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# GROUND-WATER CONDITIONS IN UTAH

SPRING OF 1997

COOPERATIVE INVESTIGATIONS

REPORT NO. 37



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SPRING OF 1997

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By

S.J. Gerner, J.I. Steiger, and others

U.S. Geological Survey

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# CONVERSION FACTORS

Multiply	By	To obtain
acre-foot	1,233	cubic meter
foot	0.3048	meter
inch	25.4	millimeter
mile	1.609	kilometer

Chemical concentration is reported only in metric units—milligrams per liter. For concentrations less than 7,000 milligrams per liter, the numerical value is about the same as for concentrations in parts per million.

## DEFINITION OF TERMS

**Acre-foot (acre-ft)**—The quantity of water required to cover 1 acre to a depth of 1 foot; equal to 43,560 cubic feet or about 326,000 gallons or 1,233 cubic meters.

**Aquifer**—A geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield substantial amounts of water to wells and springs.

**Artesian**—Describes a well in which the water level stands above the top of the aquifer tapped by the well (confined). A flowing artesian well is one in which the water level is above the land surface.

**Dissolved**—Material in a representative water sample that passes through a 0.45-micrometer membrane filter. This is a convenient operational definition used by Federal agencies that collect water data. Determinations of “dissolved” constituents are made on subsamples of the filtrate.

**Land-surface datum (lsd)**—A datum plane that is approximately at land surface at each ground-water observation well.

**Milligrams per liter (mg/L)**—A unit for expressing the concentration of chemical constituents in solution. Milligrams per liter represents the mass of solute per unit volume (liter) of water.

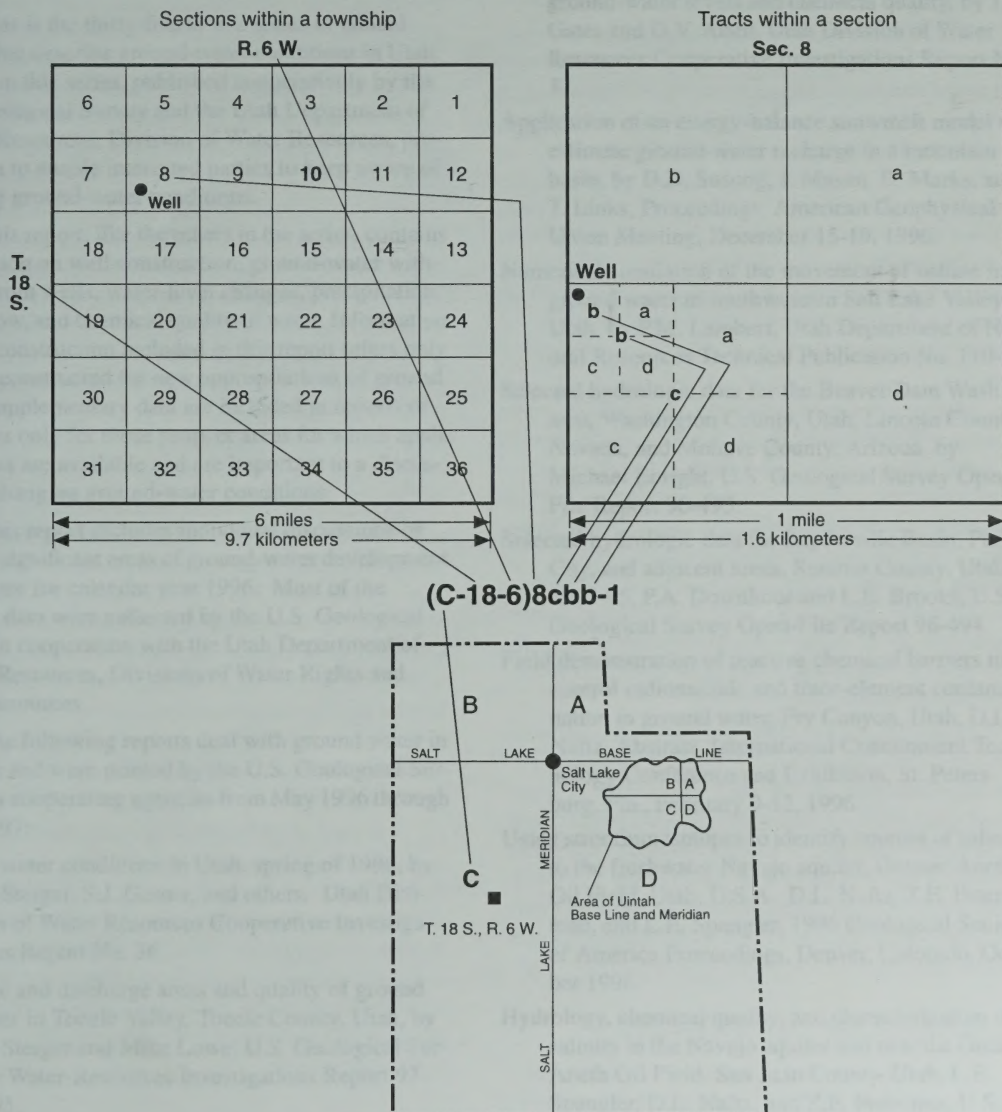
**Specific conductance**—A measure of the ability of water to conduct an electrical current. It is expressed in microsiemens per centimeter at 25 degrees Celsius. Specific conductance is related to the type and concentration of ions in solution and can be used for approximating the dissolved-solids concentration of the water. Commonly, the concentration of dissolved solids (in milligrams per liter) is about 65 percent of the specific conductance (in microsiemens). This relation is not constant in water from one well or stream to another, and it may vary for the same source with changes in the composition of the water.

**Cumulative departure from average annual precipitation**—A graph of the departure or difference between the average annual precipitation and the value of precipitation for each year, plotted cumulatively. A cumulative plot is generated by adding the departure from average precipitation for the current year to the sum of departure values for all previous years in the period of record. A positive departure, or greater-than-average precipitation, for a year results in a graph segment trending upward; a negative departure results in a graph segment trending downward. A generally downward-trending graph for a period of years represents a period of generally less-than-average precipitation, which commonly causes and correlates with declining water levels in wells. Likewise, a generally upward-trending graph for a period of years represents a period of greater-than-average precipitation, which commonly causes and correlates with rising water levels in wells. However, increases or decreases in withdrawals of ground water from wells also affect water levels and can change or eliminate the correlation between water levels in wells and the graph of cumulative departure from average precipitation.



# WELL-NUMBERING SYSTEM

The well-numbering system used in Utah is based on the Bureau of Land Management's system of land subdivision. The well-numbering system is familiar to most water users in Utah, and the well number shows the location of the well by quadrant, township, range, section, and position within the section. Well numbers for most of the State are derived from the Salt Lake Base Line and the Salt Lake Meridian. Well numbers for wells located inside the area of the Uintah Base Line and Meridian are designated in the same manner as those based on the Salt Lake Base Line and Meridian, with the addition of the "U" preceding the parentheses. The numbering system is illustrated below.







# GROUND-WATER CONDITIONS IN UTAH, SPRING OF 1997

By

S.J. Gerner, J.I. Steiger, and others

U.S. Geological Survey

## INTRODUCTION

This is the thirty-fourth in a series of annual reports that describe ground-water conditions in Utah. Reports in this series, published cooperatively by the U.S. Geological Survey and the Utah Department of Natural Resources, Division of Water Resources, provide data to enable interested parties to keep aware of changing ground-water conditions.

This report, like the others in the series, contains information on well construction, ground-water withdrawal from wells, water-level changes, precipitation, streamflow, and chemical quality of water. Information on well construction included in this report refers only to wells constructed for new appropriations of ground water. Supplementary data are included in reports of this series only for those years or areas for which applicable data are available and are important to a discussion of changing ground-water conditions.

This report includes individual discussions of selected significant areas of ground-water development in the State for calendar year 1996. Most of the reported data were collected by the U.S. Geological Survey in cooperation with the Utah Department of Natural Resources, Divisions of Water Rights and Water Resources.

The following reports deal with ground water in the State and were printed by the U.S. Geological Survey or by cooperating agencies from May 1996 through April 1997:

Ground-water conditions in Utah, spring of 1996, by J.I. Steiger, S.J. Gerner, and others, Utah Division of Water Resources Cooperative Investigations Report No. 36.

Recharge and discharge areas and quality of ground water in Tooele Valley, Tooele County, Utah, by J.I. Steiger and Mike Lowe, U.S. Geological Survey Water-Resources Investigations Report 97-4005.

Ground-water development in Utah and effects on ground-water levels and chemical quality, by J.S. Gates and D.V. Allen, Utah Division of Water Resources Cooperative Investigations Report No. 37.

Application of an energy-balance snowmelt model to estimate ground-water recharge in a mountain basin, by D.D. Susong, J. Mason, D. Marks, and T. Links, Proceedings, American Geophysical Union Meeting, December 15-19, 1996.

Numerical simulation of the movement of sulfate in ground water in southwestern Salt Lake Valley, Utah, by P.M. Lambert, Utah Department of Natural Resources Technical Publication No. 110-D.

Selected hydrologic data for the Beaver-Dam Wash area, Washington County, Utah, Lincoln County, Nevada, and Mohave County, Arizona, by Michael Enright, U.S. Geological Survey Open-File Report 96-493.

Selected hydrologic data for Snyderville Basin, Park City, and adjacent areas, Summit County, Utah, 1967-95, P.A. Downhour and L.E. Brooks, U.S. Geological Survey Open-File Report 96-494.

Field demonstration of reactive chemical barriers to control radionuclide and trace-element contamination in ground water, Fry Canyon, Utah, D.L. Naftz, Abstract, International Containment Technology Conference and Exhibition, St. Petersburg, Fla., February 9-12, 1996.

Using strontium isotopes to identify sources of salinity to the freshwater Navajo aquifer, Greater Aneth Oil Field, Utah, U.S.A., D.L. Naftz, Z.E. Peterman, and L.E. Spangler, 1996 Geological Society of America Proceedings, Denver, Colorado, October 1996.

Hydrology, chemical quality, and characterization of salinity in the Navajo aquifer and near the Greater Aneth Oil Field, San Juan County, Utah, L.E. Spangler, D.L. Naftz, and Z.E. Peterman, U.S.



Geological Survey Water-Resources Investigations Report 96-4155.

Hydrology and simulation of ground-water flow in Juab Valley, Juab County, Utah, S.A. Thiros, B.J. Stolp, H.K. Hadley, and J.I. Steiger, Utah Department of Natural Resources Technical Publication No. 114.

U.S. Geological Survey Programs in Utah, U.S. Geological Survey Fact Sheet FS-044-96.

## UTAH'S GROUND-WATER RESERVOIRS

Small amounts of ground water can be obtained from wells throughout much of Utah, but large amounts that are of suitable chemical quality for irrigation, public supply, or industrial use generally can be obtained only in specific areas. The areas of ground-water development discussed in this report are shown in figure 1 and listed in table 1. Relatively few wells outside of these areas yield large amounts of water of suitable chemical quality for the uses listed above, although some of the basins in western Utah and many areas in eastern Utah have not been explored sufficiently to determine their potential for ground-water development.

About 2 percent of the wells in Utah yield water from consolidated rock. Consolidated rocks that yield the most water are lava flows, such as basalt, which contain interconnected vesicular openings, fractures, or permeable weathered zones at the tops of flows; limestone, which contains fractures or other openings enlarged by solution; and sandstone, which contains open fractures. Most of the wells that penetrate consolidated rock are in the eastern and southern parts of the State in areas where water cannot be obtained readily from unconsolidated deposits.

About 98 percent of the wells in Utah yield water from unconsolidated deposits. These deposits may consist of boulders, gravel, sand, silt, or clay, or a mixture of some or all of these materials. The largest yields are obtained from coarse materials that are sorted into deposits of uniform grain size. Most wells that yield water from unconsolidated deposits are in large intermountain basins that have been partly filled with rock material eroded from the adjacent mountains.

## SUMMARY OF CONDITIONS

The total estimated withdrawal of water from wells in Utah during 1996 was about 858,000 acre-feet

(table 2), which is about 123,000 acre-feet more than the revised total for 1995 and 18,000 acre-feet more than the average annual withdrawal for 1986-95 (table 3).

Withdrawal in 1996 for four water-use categories: (1) irrigation, (2) industry, (3) public supply, and (4) domestic and stock, increased from the 1995 totals. Total estimated withdrawal for irrigation was about 513,000 acre-feet (table 2), which is 73,000 acre-feet more than the revised 1995 estimate and represents the largest increase in the categories. Total estimated withdrawal for public supply increased about 40,000 acre-feet from about 179,000 acre-feet in 1995 to an estimated 219,000 acre-feet in 1996. Total estimated withdrawal for industrial use was about 60,000 acre-feet, which is 4,000 acre-feet more than the revised estimated withdrawal for 1995; and the total estimated withdrawal for domestic and stock use was 64,000 acre-feet, which is 3,000 acre-feet more than for 1995.

Ground-water withdrawal increased from 1995 to 1996 in 14 of the 16 areas of ground-water development discussed in this report (table 2). Withdrawal in Utah and Goshen Valleys and in the Beryl-Enterprise area increased about 22,000 acre-feet each, the largest increases of the ground-water development areas. Withdrawal decreased about 3,000 acre-feet in Tooele Valley and 1,000 acre-feet in Sevier Desert. The 1996 withdrawal was more than the average annual withdrawals for 1986-95 in 10 of the 16 areas.

The amount of water withdrawn from wells is related to demand and availability of water from other sources, which, in turn, are partly related to local climatic conditions. Precipitation during calendar year 1996 at 19 of 32 weather stations included in this report (National Oceanic and Atmospheric Administration, 1996) was greater than the long-term average. The largest positive departure from average in 1996 is the 13.03 inches recorded at Silver Lake near Brighton, and the largest negative departure from average is the 2.55 inches recorded at Monticello in southeastern Utah.

A total of 756 wells were constructed for new appropriations of ground water in 1996, as determined by the Utah Division of Water Rights (table 2). This is 49 more wells than were reported for 1995 and 29 more than were reported for 1994. In 1996, 84 large-diameter wells (12 inches or more) were constructed for new appropriations of ground water. These are principally for withdrawal of water for public supply, irrigation, and industrial use.



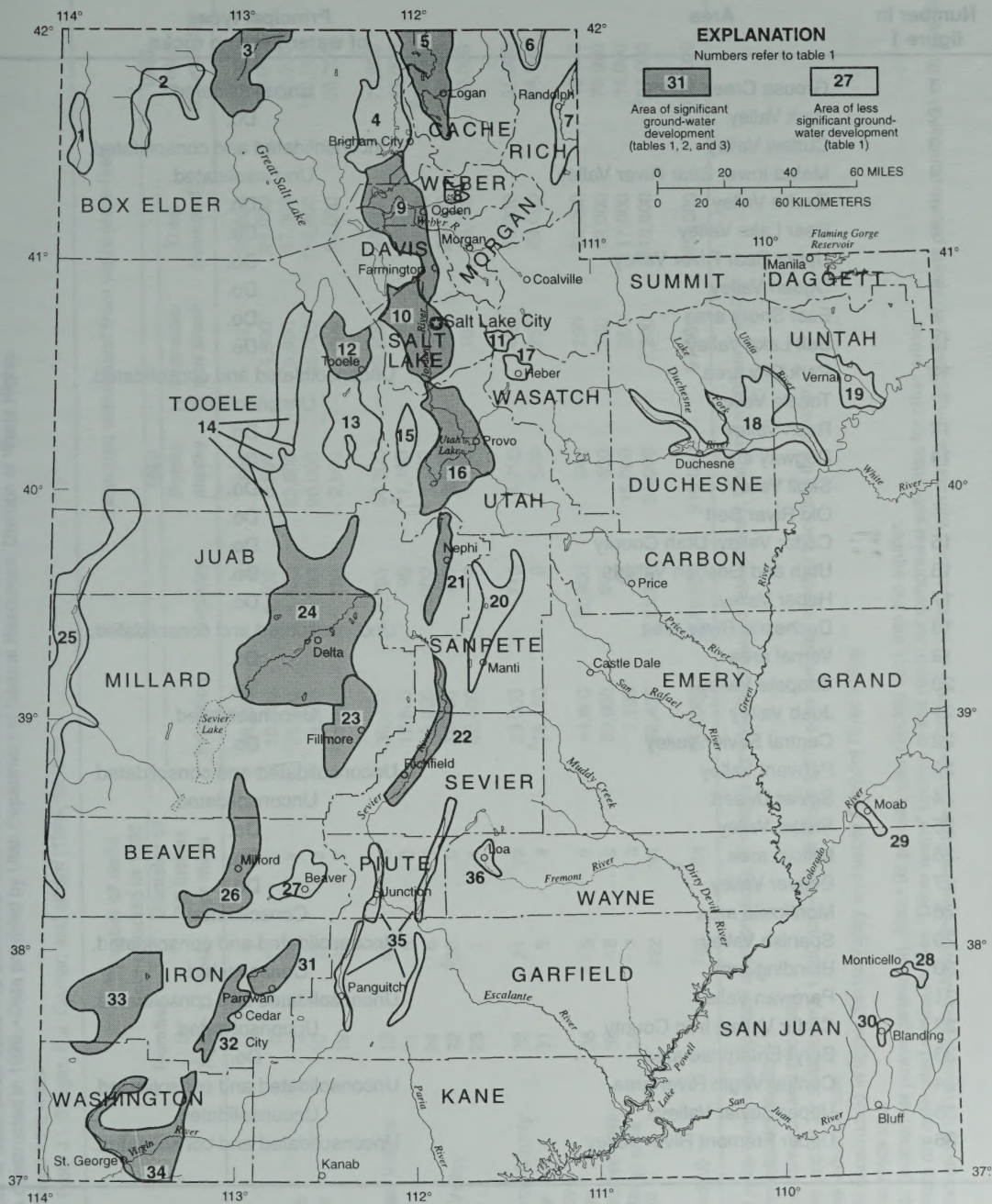


Figure 1. Areas of ground-water development in Utah specifically referred to in this report.

**Table 1.** Areas of ground-water development in Utah specifically referred to in this report

Number in figure 1	Area	Principal types of water-bearing rocks
1	Grouse Creek Valley	Unconsolidated.
2	Park Valley	Do.
3	Curlew Valley	Unconsolidated and consolidated.
4	Malad-lower Bear River Valley	Unconsolidated.
5	Cache Valley	Do.
6	Bear Lake Valley	Do.
7	Upper Bear River Valley	Do.
8	Ogden Valley	Do.
9	East Shore area	Do.
10	Salt Lake Valley	Do.
11	Park City area	Unconsolidated and consolidated.
12	Tooele Valley	Unconsolidated.
13	Rush Valley	Do.
14	Dugway area	Do.
	Skull Valley	Do.
	Old River Bed	Do.
15	Cedar Valley, Utah County	Do.
16	Utah and Goshen Valleys	Do.
17	Heber Valley	Do.
18	Duchesne River area	Unconsolidated and consolidated.
19	Vernal area	Do.
20	Sanpete Valley	Do.
21	Juab Valley	Unconsolidated.
22	Central Sevier Valley	Do.
23	Pahvant Valley	Unconsolidated and consolidated.
24	Sevier Desert	Unconsolidated.
25	Snake Valley	Do.
26	Milford area	Do.
27	Beaver Valley	Do.
28	Monticello area	Consolidated.
29	Spanish Valley	Unconsolidated and consolidated.
30	Blanding area	Consolidated.
31	Parowan Valley	Unconsolidated and consolidated.
32	Cedar Valley, Iron County	Unconsolidated.
33	Beryl-Enterprise area	Do.
34	Central Virgin River area	Unconsolidated and consolidated.
35	Upper Sevier Valleys	Unconsolidated.
36	Upper Fremont River Valley	Unconsolidated and consolidated.



**Table 2.** Number of wells constructed and estimated withdrawal of water from wells in Utah  
Number of wells constructed in 1996—Data provided by Utah Department of Natural Resources, Division of Water Rights.  
Estimated withdrawal from wells—  
1995 total: From J.I. Steiger, S.J. Gerner, and others (1996, table 2).

	Number in figure 1	<sup>1</sup> Number of wells constructed in 1996		Estimated withdrawal from wells (acre-feet)					
		Total	Diameter of 12 inches or more			1996			1995 Total (rounded)
				Irrigation	Industry	Public supply	Domestic and stock	Total (rounded)	
Curlew Valley	3	1	1	38,700	0	180	100	39,000	31,000
Cache Valley	5	47	5	10,100	6,400	5,500	1,800	24,000	<sup>2</sup> 23,000
East Shore area	9	13	1	<sup>3</sup> 25,400	3,500	23,500	5,000	57,000	53,000
Salt Lake Valley	10	23	2	4,300	<sup>4</sup> 18,600	90,000	25,000	138,000	120,000
Tooele Valley	12	83	7	<sup>3</sup> 18,600	820	2,900	300	23,000	26,000
Utah and Goshen Valleys	16	65	3	38,800	3,700	36,300	20,200	99,000	77,000
Juab Valley	21	5	0	17,600	90	<sup>5</sup> 1,100	400	19,000	13,000
Sevier Desert	24	6	0	9,200	6,000	1,700	350	17,000	<sup>2</sup> 18,000
Central Sevier Valley	22	<sup>6</sup> 30	0	16,700	160	2,000	2,000	21,000	20,000
Pahvant Valley	23	1	1	82,000	0	620	100	83,000	69,000
Cedar Valley, Iron County	32	21	13	29,000	710	4,700	420	35,000	31,000
Parowan Valley	31	9	3	<sup>7</sup> 28,100	0	520	250	29,000	24,000
Escalante Valley									
Milford area	26	5	3	44,600	<sup>8</sup> 6,400	940	250	52,000	48,000
Beryl-Enterprise area	33	18	8	89,600	600	530	750	92,000	70,000
Central Virgin River area	34	7	3	1,700	90	15,000	250	17,000	15,000
Other areas <sup>9,10</sup>		422	34	58,400	13,200	34,000	7,200	113,000	<sup>2</sup> 97,000
Total (rounded)		756	84	513,000	60,000	219,000	64,000	858,000	<sup>2</sup> 735,000

<sup>1</sup> Includes only wells constructed for new appropriations. Previous reports also included replacement, test, and monitoring wells.

<sup>2</sup> Previously unpublished revision.

<sup>3</sup> Includes some domestic and stock use.

<sup>4</sup> Includes some use for air conditioning, 1,980 acre-feet, of which 1,670 acre-feet was injected back into the aquifer.

<sup>5</sup> Includes some industrial use.

<sup>6</sup> Includes wells constructed in upper Sevier Valley and upper Fremont River Valley.

<sup>7</sup> Includes some stock use.

<sup>8</sup> Withdrawal for geothermal power generation. About 99 percent was injected back into the aquifer.

<sup>9</sup> Withdrawal totals are estimated minimum. See "Other areas" section of this report for withdrawal estimates for other areas.

<sup>10</sup> Includes withdrawals for upper Sevier Valley and upper Fremont River Valley that were included with central Sevier Valley in reports prior to number 31 of this series.

**Table 3.** Total annual withdrawal of water from wells in significant areas of ground-water development in Utah, 1986-95  
 [From previous reports of this series]

Area	Number in figure 1	Thousands of acre-feet										1986-95 average (rounded)
		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	
Curlew Valley	3	26	29	34	29	43	37	44	35	41	31	35
Cache Valley	5	23	26	33	30	32	29	36	23	31	23	29
East Shore area	9	66	67	68	61	65	68	59	56	60	53	62
Salt Lake Valley	10	104	122	165	157	143	135	138	116	142	120	134
Tooele Valley	12	21	22	26	27	33	30	30	22	31	26	27
Utah and Goshen Valleys	16	75	104	113	121	129	124	141	89	114	77	109
Juab Valley	21	10	22	22	28	27	25	29	20	26	13	22
Sevier Desert	24	11	15	15	17	34	34	33	31	37	18	24
Central Sevier Valley <sup>1</sup>	22	18	18	17	18	18	18	19	19	20	20	18
Pahvant Valley	23	60	66	71	82	88	74	86	87	93	69	78
Cedar Valley, Iron County	32	19	21	20	28	30	34	34	33	34	31	28
Parowan Valley	31	24	22	20	29	31	32	31	28	30	24	27
Escalante Valley												
Milford area	26	46	44	40	46	48	54	42	50	61	48	48
Beryl-Enterprise area	33	93	97	88	85	86	79	72	78	86	70	83
Central Virgin River area	34	20	20	18	23	22	15	14	13	14	15	17
Other areas		72	79	95	100	111	111	120	94	113	97	99
Total		688	774	845	881	940	899	928	794	933	735	840

<sup>1</sup> Prior to 1991, included upper Sevier and upper Fremont River Valleys.



# MAJOR AREAS OF GROUND-WATER DEVELOPMENT

## CURLEW VALLEY

By J.D. Sory

Total estimated withdrawal of water from wells in Curlew Valley in 1996 was about 39,000 acre-feet, which is 8,000 acre-feet more than was reported for 1995 and 4,000 acre-feet more than the average annual withdrawal for 1986-95 (tables 2 and 3).

The location of wells in Curlew Valley in which the water level was measured during March 1997 is shown in figure 2. The relation of the water level in selected observation wells to cumulative departure from average annual precipitation at Grouse Creek, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells is shown in figure 3. Water levels in March in Curlew Valley generally rose from 1982 to 1985-87 during a period of much-greater-than-normal precipitation, and generally

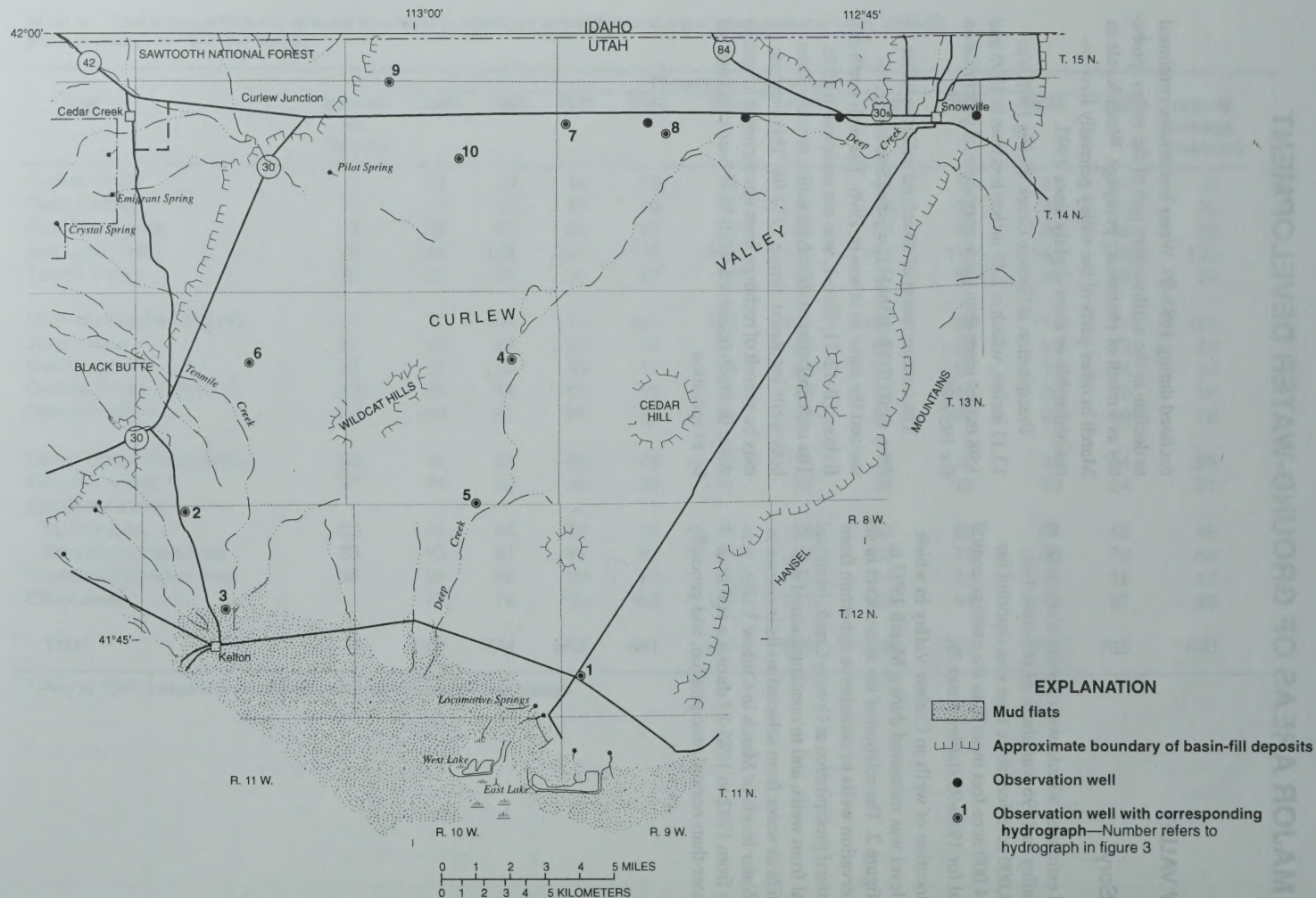
declined during 1985-89. Water levels have continued to decline in the northwestern part of the valley, probably as a result of continuing pumpage. Water levels in March in other parts of the valley generally have remained stable or risen slightly since 1993.

Precipitation at Grouse Creek during 1996 was 13.11 inches, which is 2.48 inches less than in 1995 and 1.98 inches more than the average annual precipitation for 1959-96.

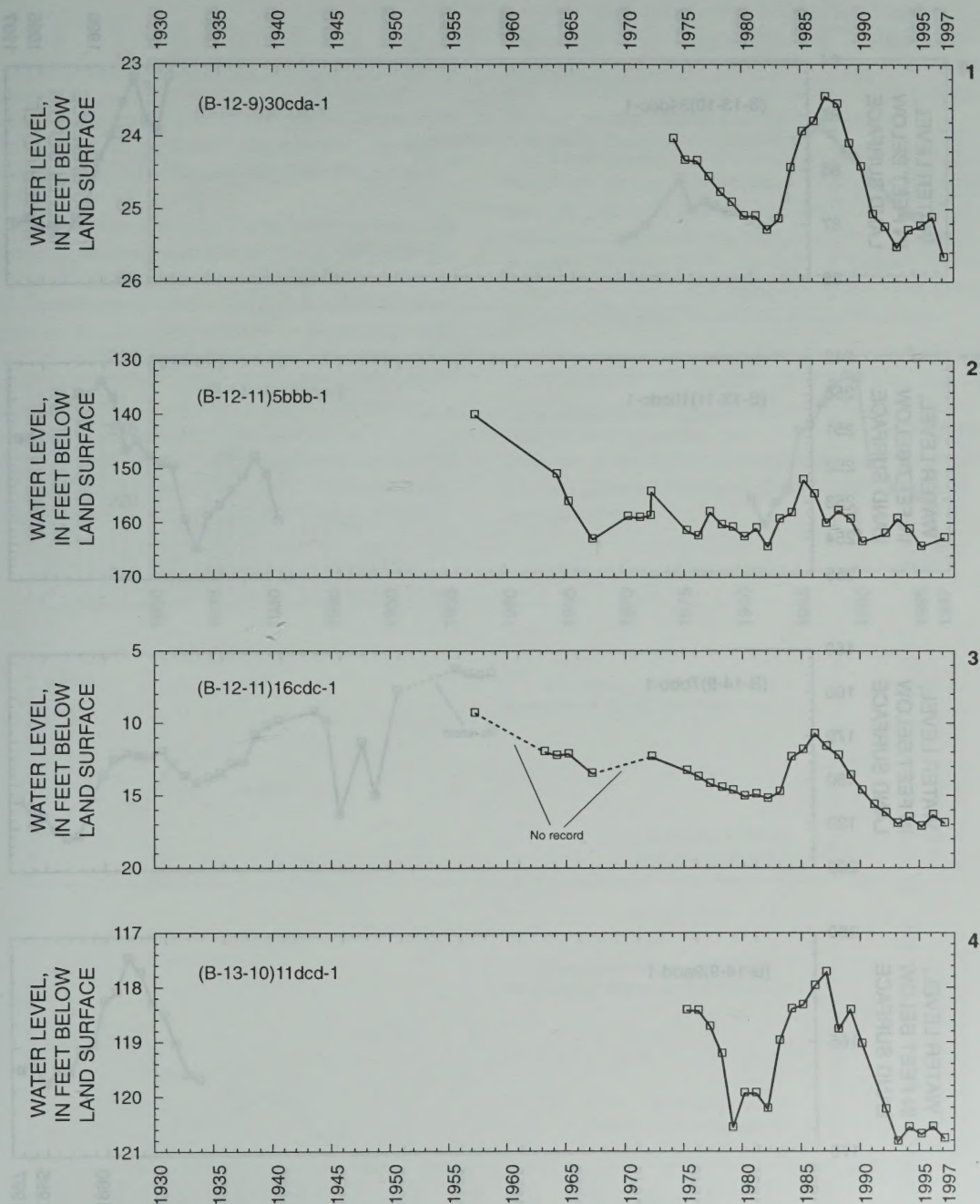
The concentration of dissolved solids in water from well (B-14-9)5bbb-1, west of Snowville, remained the same as it was in 1996. The well north of Kelton, (B-12-11)4bcc-1, was not sampled in 1996. The concentration of dissolved solids in water from both wells increased during 1972-96. This increase may be a result of recharge from unconsumed irrigation water in which dissolved solids have been concentrated by evaporation.



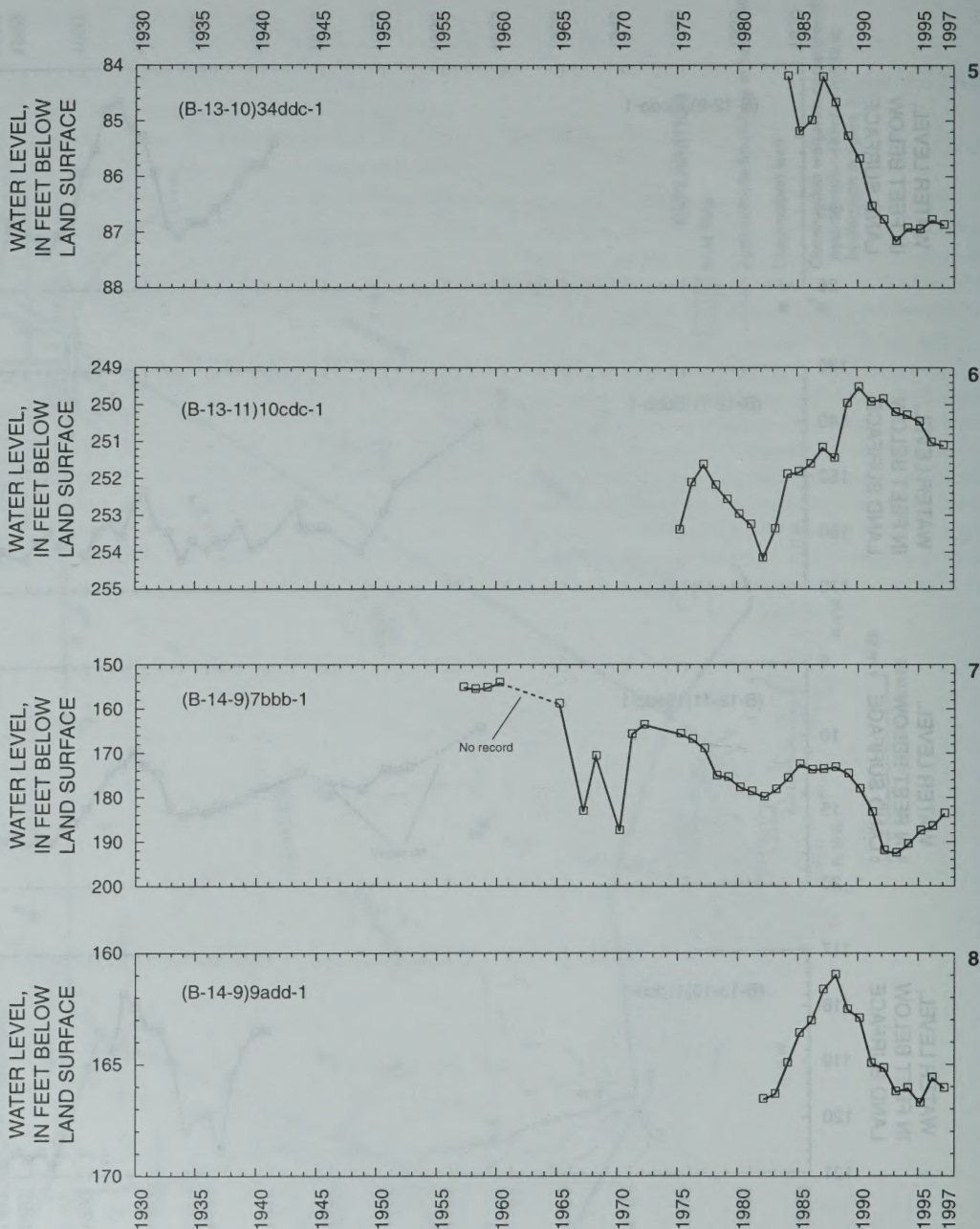
Figure 2. Location of wells in Curlew Valley in which the water level was measured during March 1997. The map shows the distribution of wells and the corresponding water levels measured in March 1997. The water level is shown in feet below the land surface. The map also indicates the cumulative departure from average annual precipitation at Grouse Creek, annual withdrawal from wells, and the concentration of dissolved solids in water from selected wells.





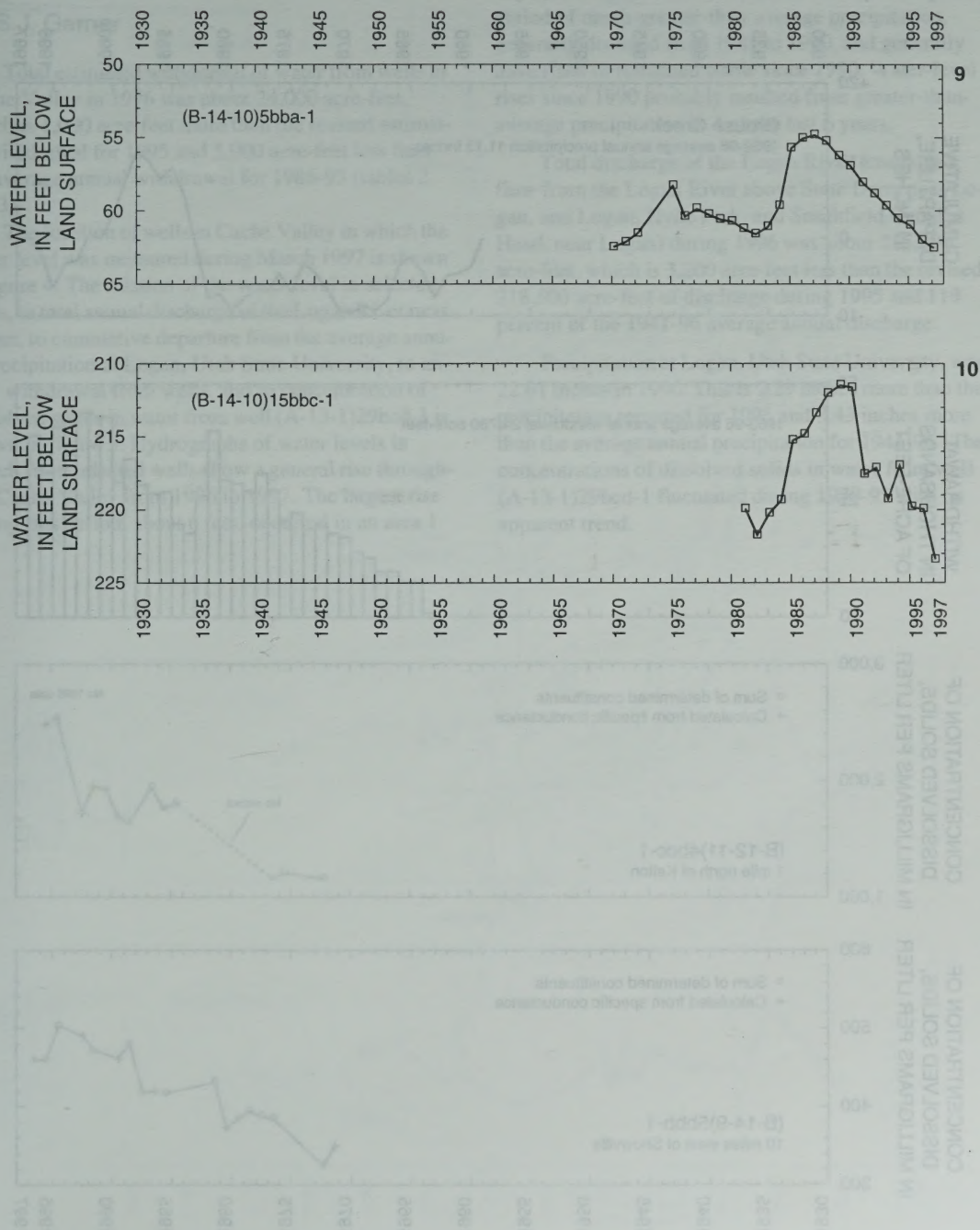


**Figure 3.** Relation of water level in selected wells in Curlew Valley to cumulative departure from average annual precipitation at Grouse Creek, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells.

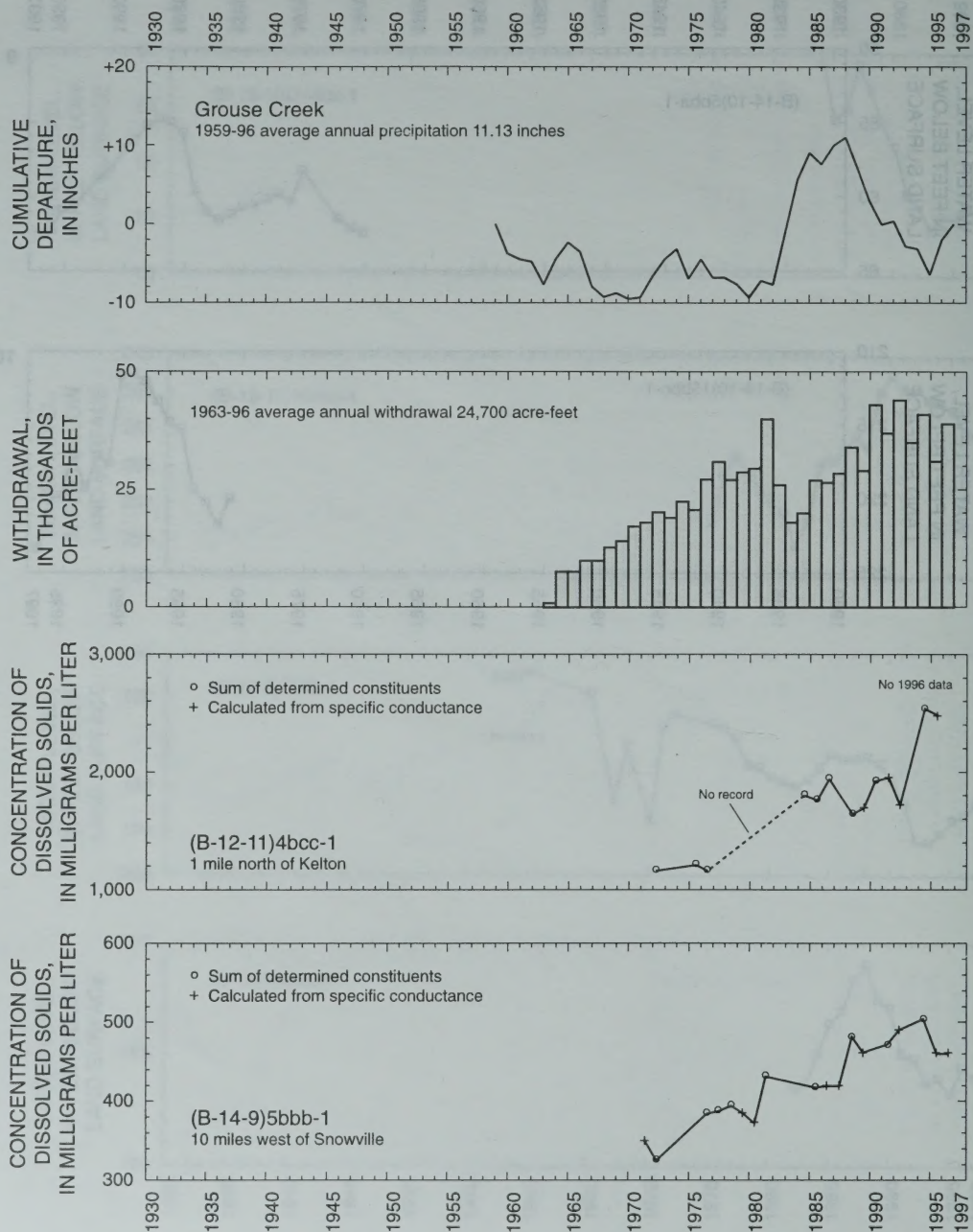


**Figure 3.** Relation of water level in selected wells in Curlew Valley to cumulative departure from average annual precipitation at Grouse Creek, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells—Continued.





**Figure 3.** Relation of water level in selected wells in Curlew Valley to cumulative departure from average annual precipitation at Grouse Creek, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells—Continued.



**Figure 3.** Relation of water level in selected wells in Curlew Valley to cumulative departure from average annual precipitation at Grouse Creek, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells—Continued.



## CACHE VALLEY

By S.J. Gerner

Total estimated withdrawal of water from wells in Cache Valley in 1996 was about 24,000 acre-feet, which is 1,000 acre-feet more than the revised estimated withdrawal for 1995 and 5,000 acre-feet less than the average annual withdrawal for 1986-95 (tables 2 and 3).

The location of wells in Cache Valley in which the water level was measured during March 1997 is shown in figure 4. The relation of the water level in selected wells, to total annual discharge of the Logan River near Logan, to cumulative departure from the average annual precipitation at Logan, Utah State University, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (A-13-1)29bcd-1 is shown in figure 5. Hydrographs of water levels in March from selected wells show a general rise throughout Cache Valley from 1996 to 1997. The largest rise during this period, about 6 feet, occurred in an area 1

mile south of Richmond. Water levels in March generally rose from about 1980 to 1985, corresponding to a period of much-greater-than-average precipitation, generally declined from 1985 to 1990, and generally have risen or remained stable since 1990. Water-level rises since 1990 probably resulted from greater-than-average precipitation in 4 of the last 6 years.

Total discharge of the Logan River (combined flow from the Logan River above State Dam, near Logan, and Logan, Hyde Park, and Smithfield Canal at Head, near Logan) during 1996 was about 215,300 acre-feet, which is 3,200 acre-feet less than the revised 218,500 acre-feet of discharge during 1995 and 119 percent of the 1941-96 average annual discharge.

Precipitation at Logan, Utah State University, was 22.07 inches in 1996. This is 2.29 inches more than the precipitation reported for 1995 and 3.43 inches more than the average annual precipitation for 1941-96. The concentrations of dissolved solids in water from well (A-13-1)29bcd-1 fluctuated during 1970-95 with no apparent trend.



Figure 5. Relation of water level in selected wells in Cache Valley to total annual discharge of the Logan River near Logan, to cumulative departure from the average annual precipitation at Logan, Utah State University, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (A-13-1)29bcd-1.

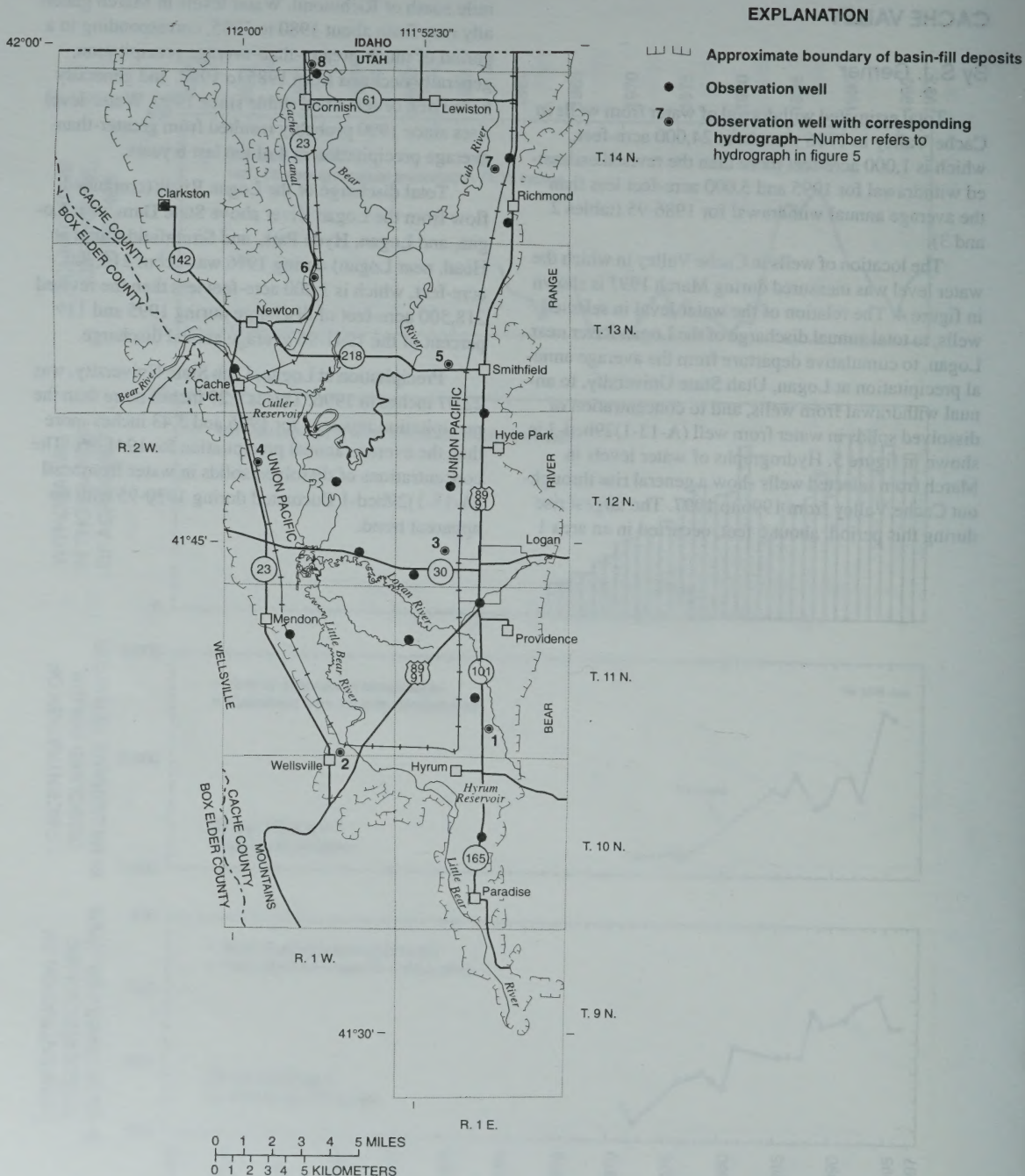
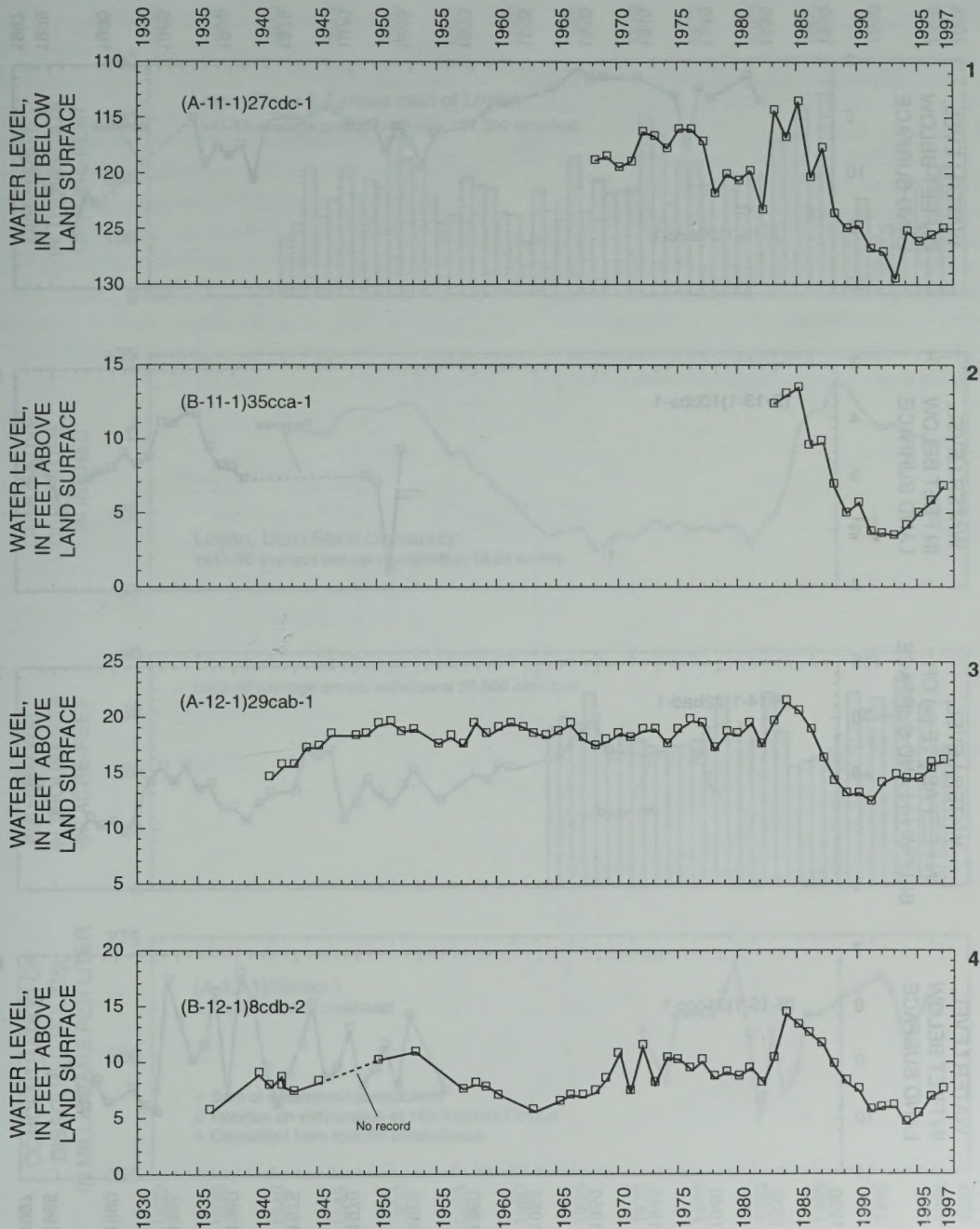


Figure 4. Location of wells in Cache Valley in which the water level was measured during March 1997.





**Figure 5.** Relation of water level in selected wells in Cache Valley to total annual discharge of the Logan River near Logan, to cumulative departure from average annual precipitation at Logan, Utah State University, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (A-13-1)29bcd-1.

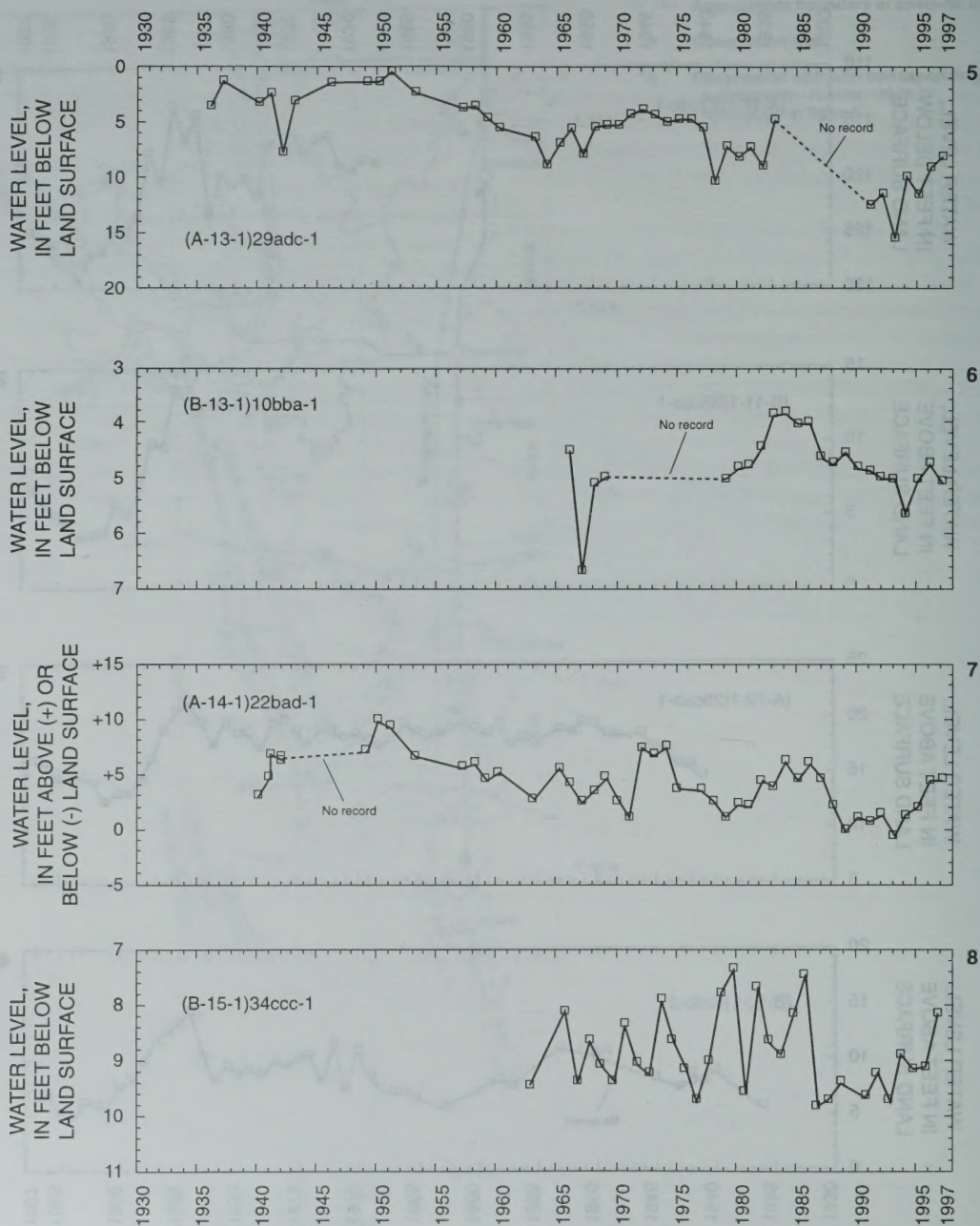
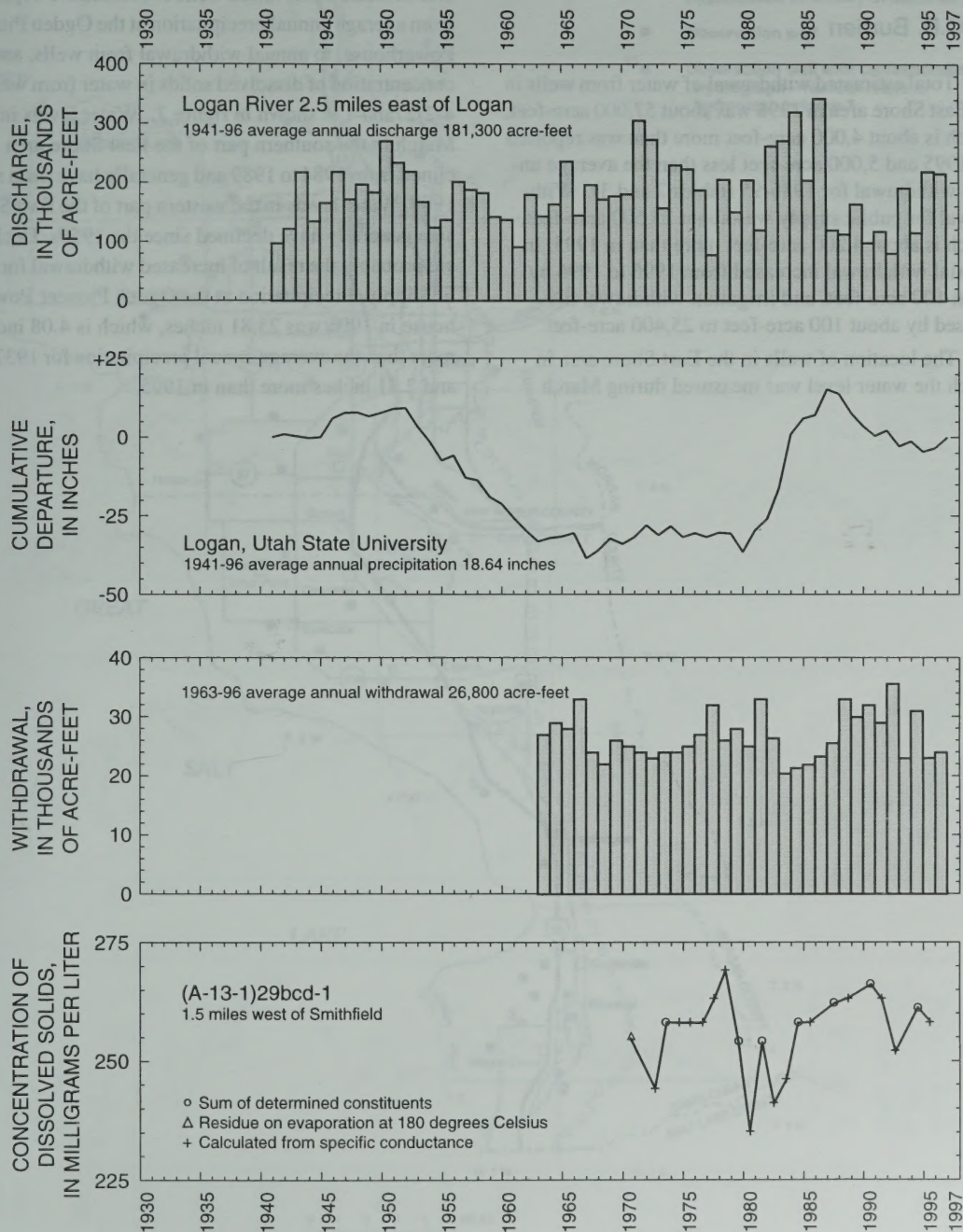


Figure 5. Relation of water level in selected wells in Cache Valley to total annual discharge of the Logan River near Logan, to cumulative departure from average annual precipitation at Logan, Utah State University, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (A-13-1)29bcd-1—Continued.





**Figure 5.** Relation of water level in selected wells in Cache Valley to total annual discharge of the Logan River near Logan, to cumulative departure from average annual precipitation at Logan, Utah State University, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (A-13-1)29bcd-1—Continued.

## EAST SHORE AREA

By C.B. Burden

Total estimated withdrawal of water from wells in the East Shore area in 1996 was about 57,000 acre-feet, which is about 4,000 acre-feet more than was reported for 1995 and 5,000 acre-feet less than the average annual withdrawal for 1986-95 (tables 2 and 3). Withdrawal for public supply was about 23,500 acre-feet, which is about 4,200 acre-feet more than in 1995. Industrial withdrawal increased from 1995 to 1996 by about 100 acre-feet, and irrigation withdrawal increased by about 100 acre-feet to 25,400 acre-feet.

The location of wells in the East Shore area in which the water level was measured during March

1997 is shown in figure 6. The relation of the water level in selected observation wells to cumulative departure from average annual precipitation at the Ogden Pioneer Powerhouse, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (B-4-2)27aba-1 is shown in figure 7. Water levels in March in the southern part of the East Shore area declined from 1984 to 1989 and generally have risen since 1989. Water levels in the western part of the East Shore area generally have declined since the 1950s. Declines are probably the result of increased withdrawal for public supply. Precipitation at the Ogden Pioneer Powerhouse in 1996 was 25.81 inches, which is 4.08 inches more than the average annual precipitation for 1937-96, and 2.31 inches more than in 1995.





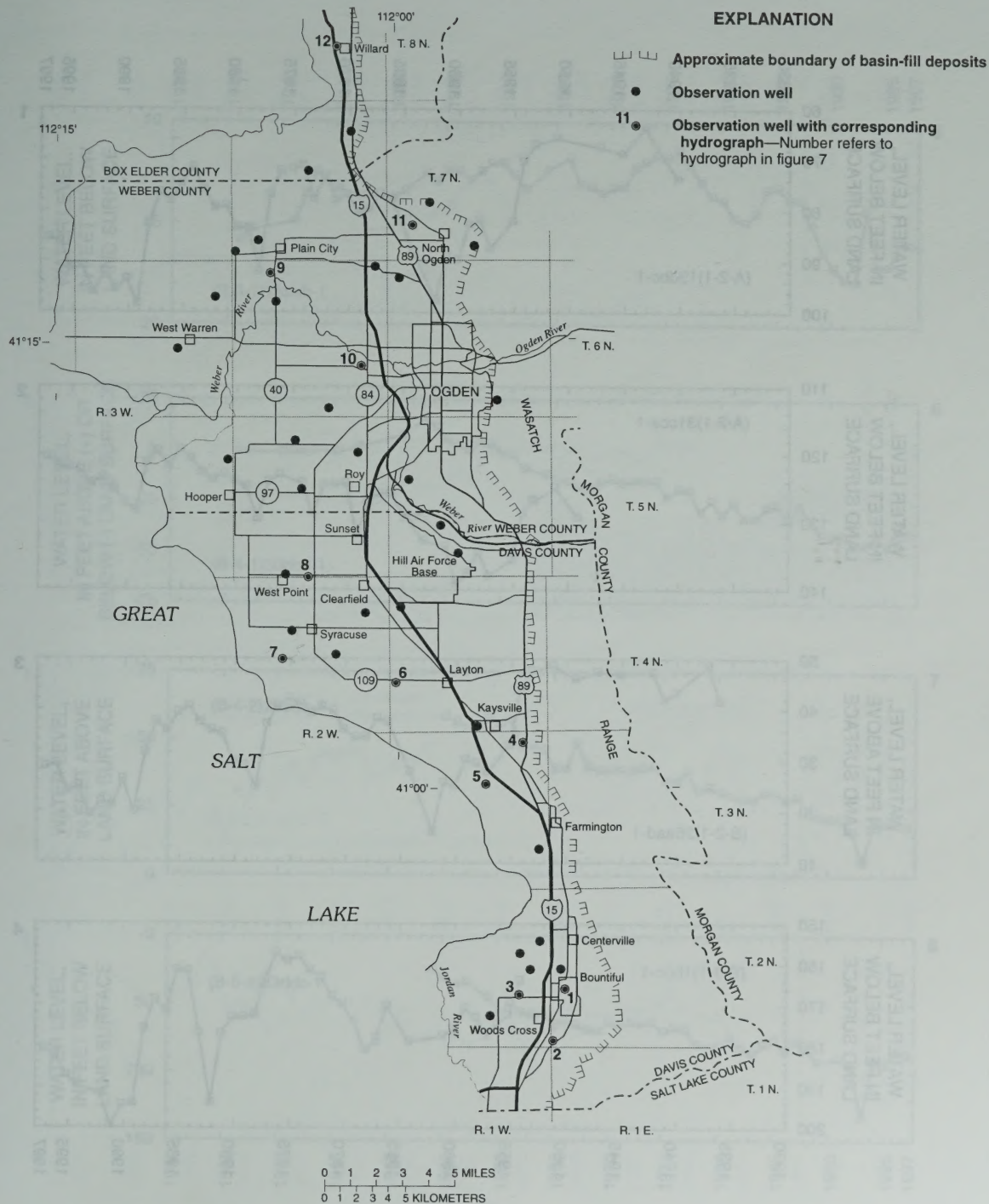
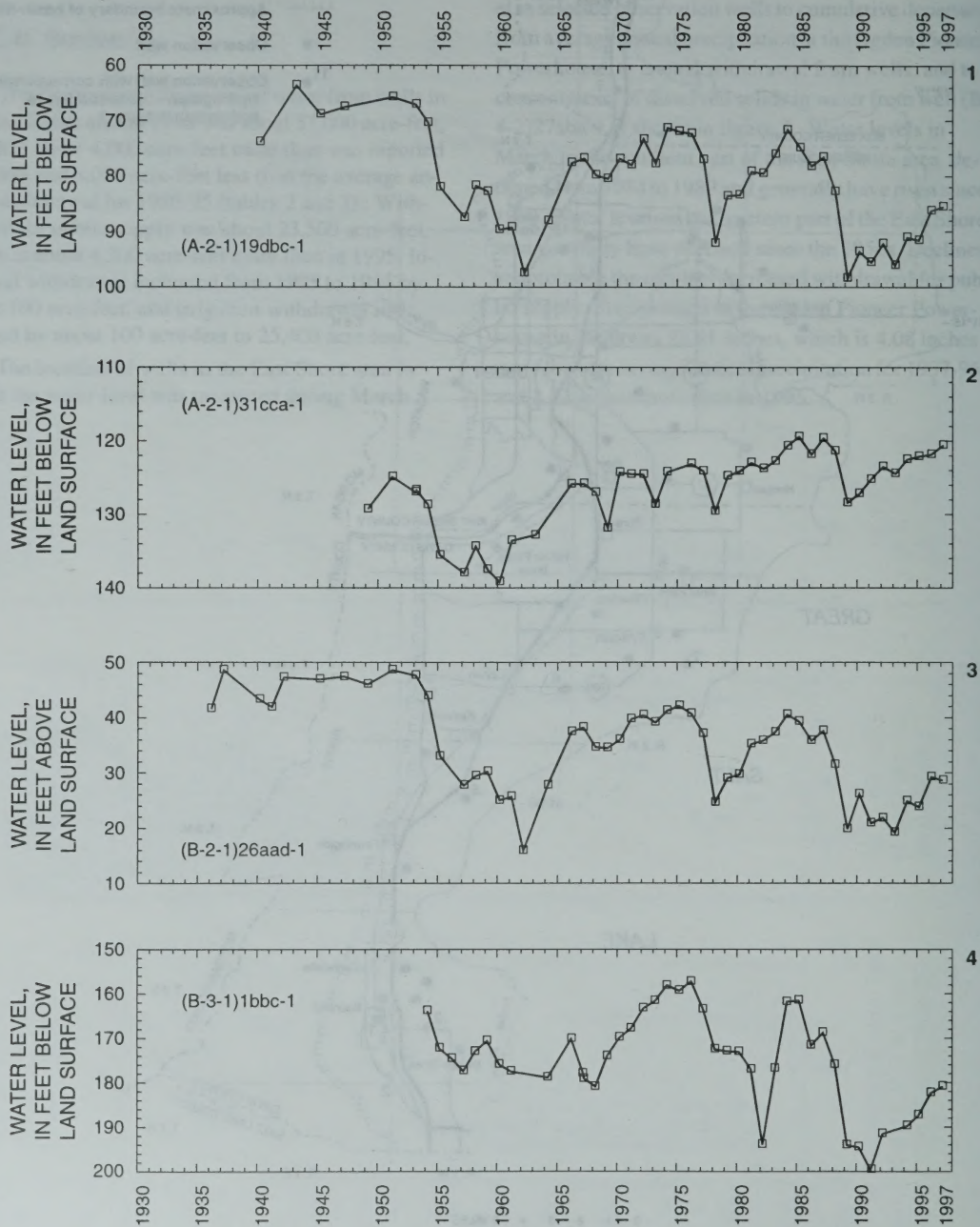
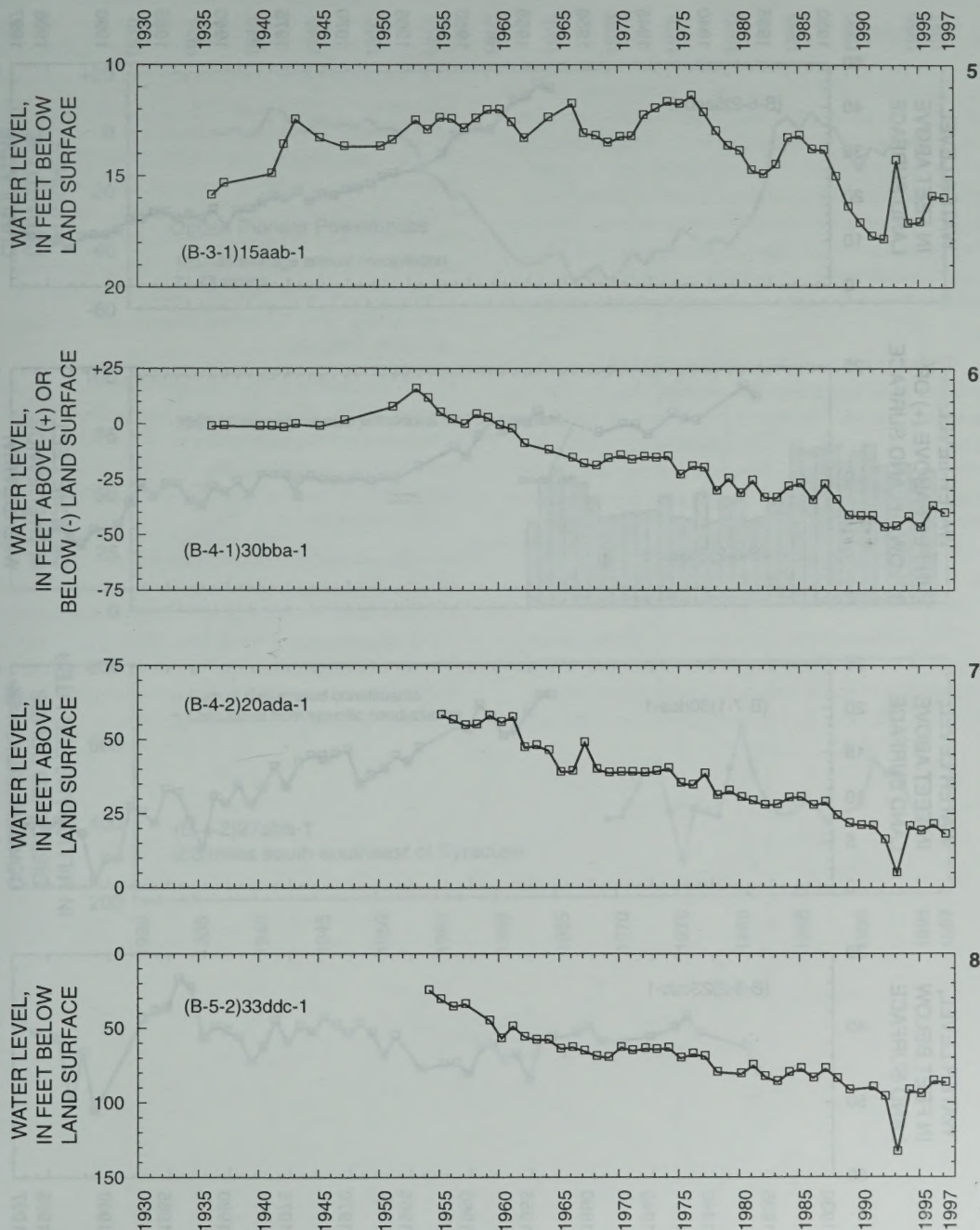


Figure 6. Location of wells in the East Shore area in which the water level was measured during March 1997.

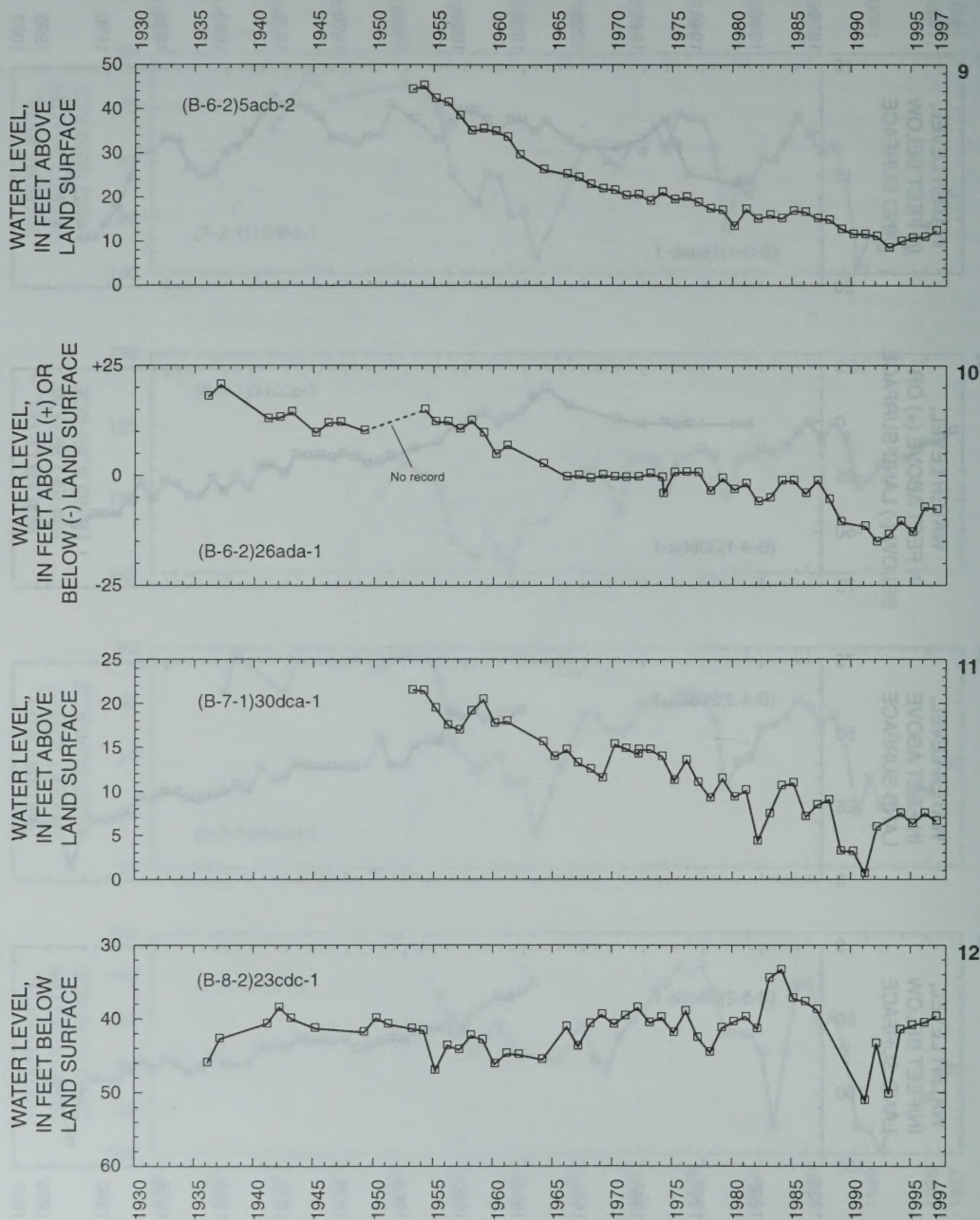


**Figure 7.** Relation of water level in selected wells in the East Shore area to cumulative departure from average annual precipitation at Ogden Pioneer Powerhouse, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (B-4-2)27aba-1.



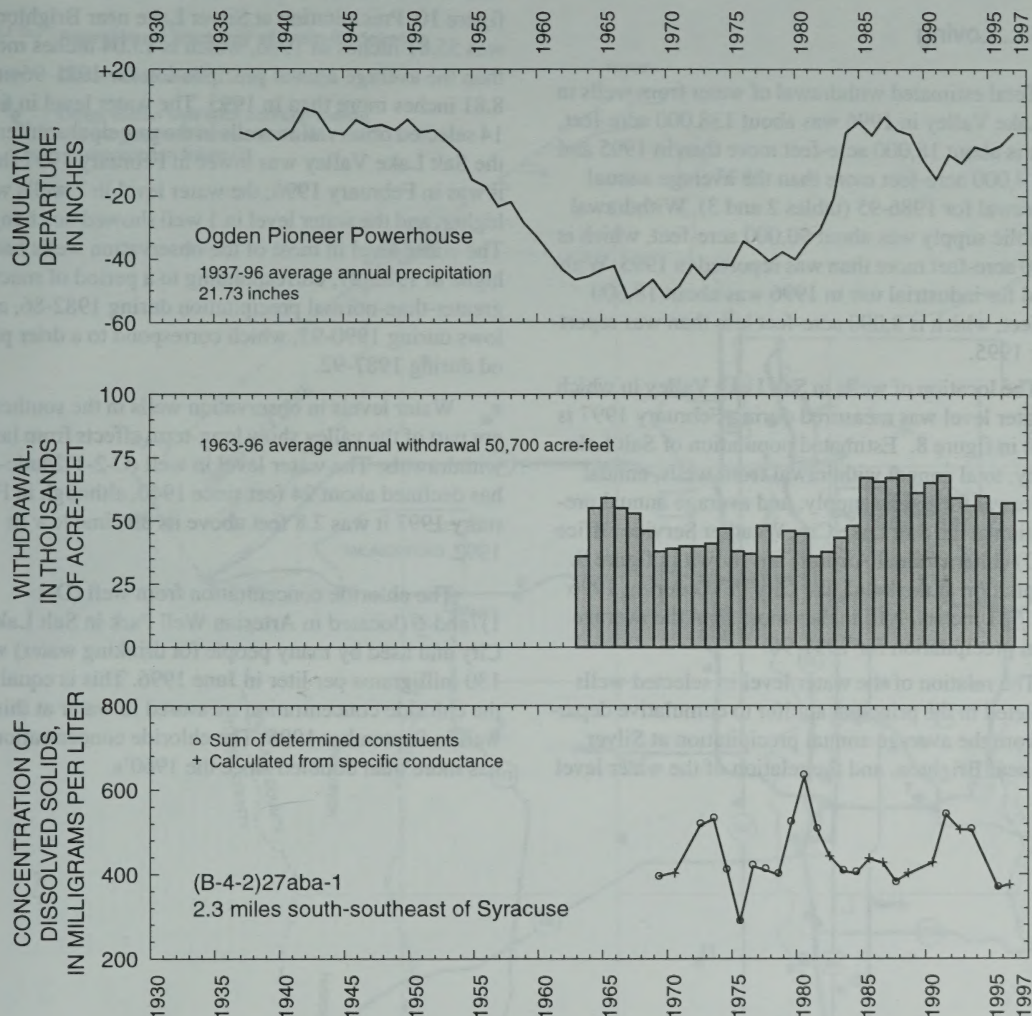


**Figure 7.** Relation of water level in selected wells in the East Shore area to cumulative departure from average annual precipitation at Ogden Pioneer Powerhouse, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (B-4-2)27aba-1—Continued.



**Figure 7.** Relation of water level in selected wells in the East Shore area to cumulative departure from average annual precipitation at Ogden Pioneer Powerhouse, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (B-4-2)27aba-1—Continued.





**Figure 7.** Relation of water level in selected wells in the East Shore area to cumulative departure from average annual precipitation at Ogden Pioneer Powerhouse, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (B-4-2)27aba-1—Continued.

## SALT LAKE VALLEY

By B.L. Loving

Total estimated withdrawal of water from wells in Salt Lake Valley in 1996 was about 138,000 acre-feet, which is about 18,000 acre-feet more than in 1995 and about 4,000 acre-feet more than the average annual withdrawal for 1986-95 (tables 2 and 3). Withdrawal for public supply was about 90,000 acre-feet, which is 14,400 acre-feet more than was reported in 1995. Withdrawal for industrial use in 1996 was about 18,600 acre-feet, which is 2,000 acre-feet less than was reported for 1995.

The location of wells in Salt Lake Valley in which the water level was measured during February 1997 is shown in figure 8. Estimated population of Salt Lake County, total annual withdrawal from wells, annual withdrawal for public supply, and average annual precipitation at the Salt Lake City Weather Service Office (WSO) (International Airport) are shown in figure 9. Precipitation at the Salt Lake City WSO during 1996 was 17.31 inches, 2.15 inches more than the average annual precipitation for 1931-96.

The relation of the water level in selected wells completed in the principal aquifer to cumulative departure from the average annual precipitation at Silver Lake near Brighton, and the relation of the water level

in well (D-1-1)7abd-6 to concentration of chloride and dissolved solids in water from the well are shown in figure 10. Precipitation at Silver Lake near Brighton was 55.81 inches in 1996, which is 13.04 inches more than the average annual precipitation for 1931-96 and 8.81 inches more than in 1995. The water level in 6 of 14 selected observation wells in the principal aquifer of the Salt Lake Valley was lower in February 1997 than it was in February 1996; the water level in 7 wells was higher; and the water level in 1 well showed no change. The water level in most of the observation wells had highs in 1985-87, corresponding to a period of much-greater-than-normal precipitation during 1982-86, and lows during 1990-93, which correspond to a drier period during 1987-92.

Water levels in observation wells in the southeastern part of the valley show long-term effects from large withdrawals. The water level in well (C-2-1)24dc-1 has declined about 24 feet since 1940, although in February 1997 it was 2.8 feet above its all-time low in 1992.

The chloride concentration from well (D-1-1)7abd-6 (located in Artesian Well Park in Salt Lake City and used by many people for drinking water) was 130 milligrams per liter in June 1996. This is equal to the chloride concentration measured in water at this well in September 1995. The chloride concentration has more than doubled since the 1960's.



## EXPLANATION

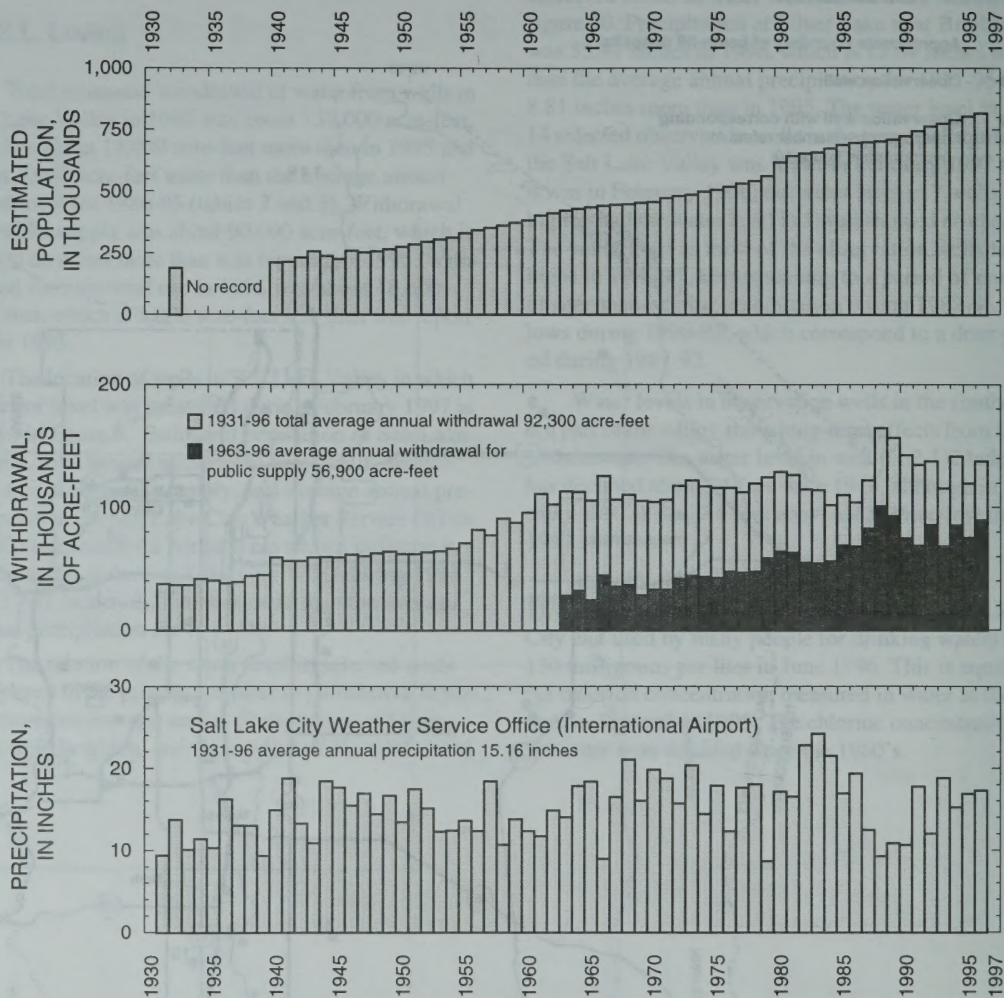
— Approximate boundary of basin-fill deposits

● Observation well

3 ● Observation well with corresponding hydrograph—Number refers to hydrograph in figure 10

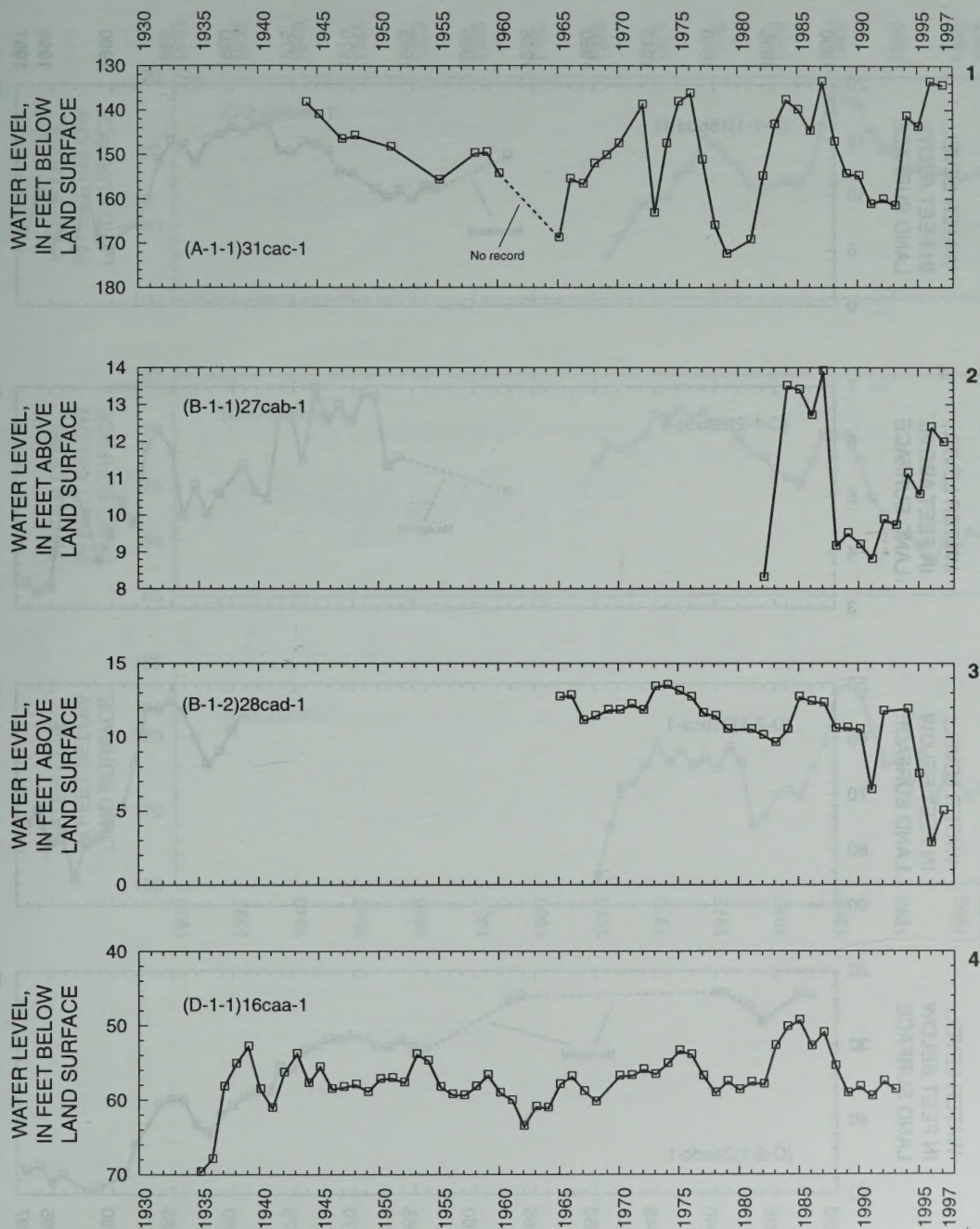


Figure 8. Location of wells in Salt Lake Valley in which the water level was measured during February 1997.

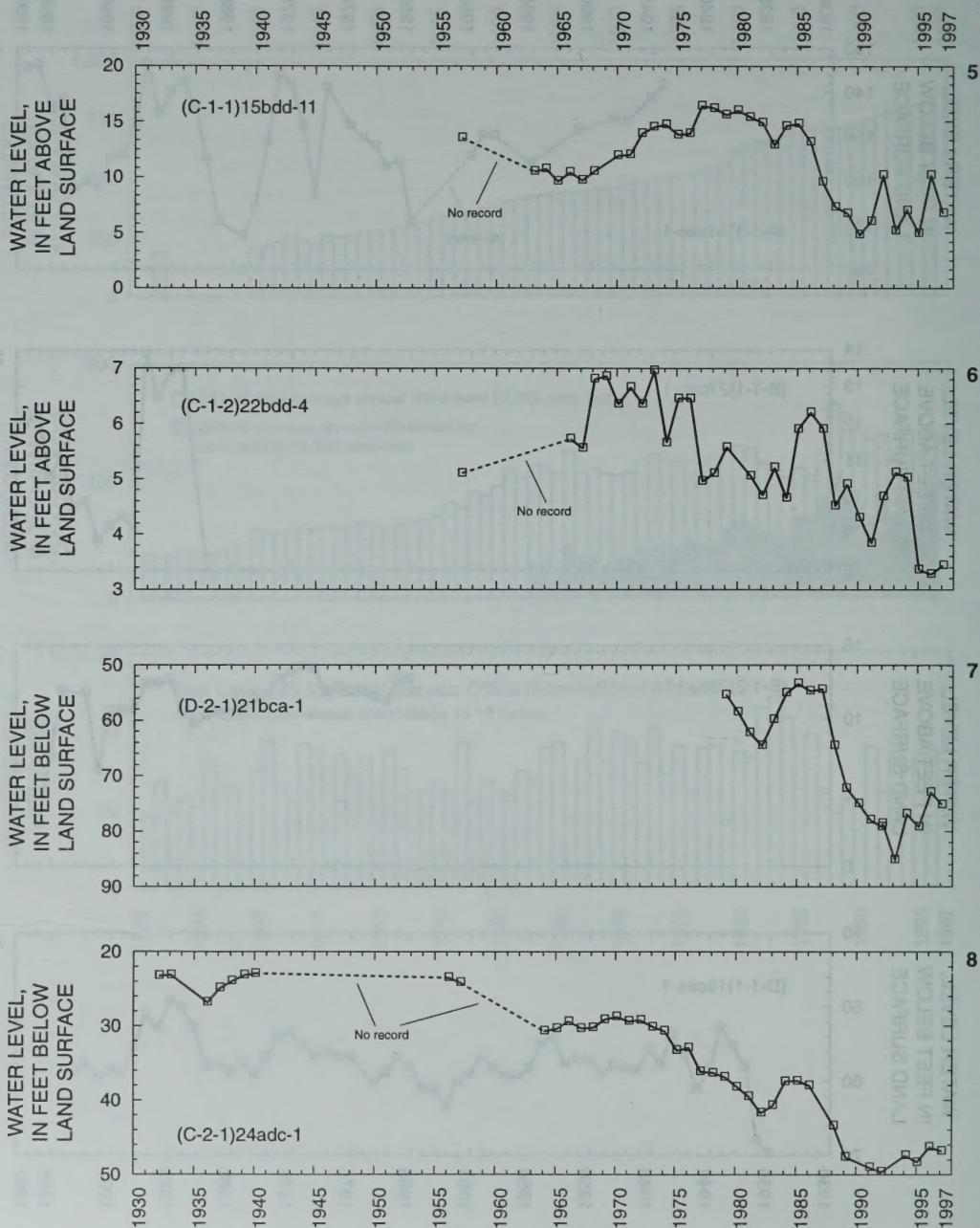


**Figure 9.** Estimated population of Salt Lake County, total annual withdrawal from wells, annual withdrawal for public supply, and average annual precipitation at Salt Lake City Weather Service Office (International Airport).



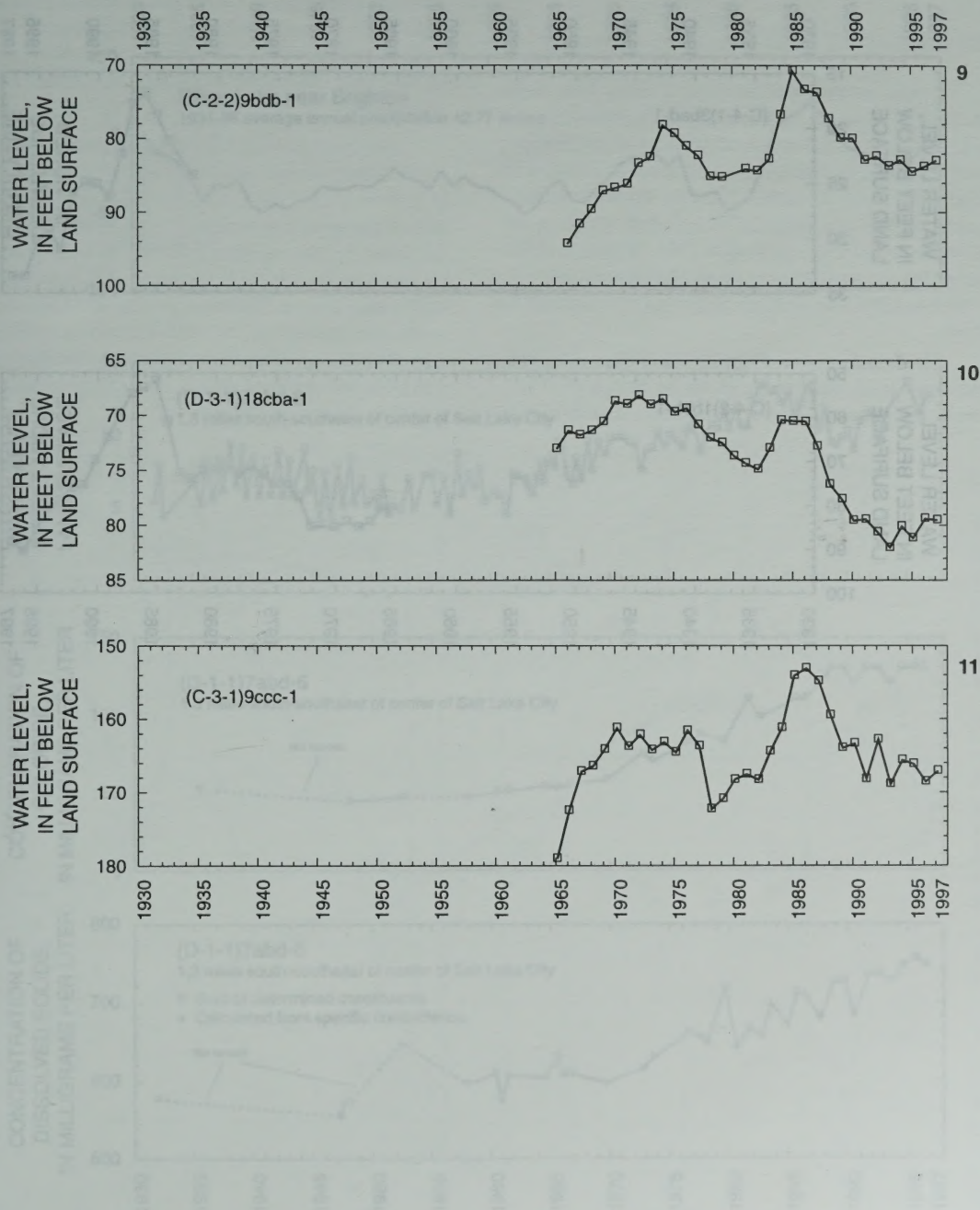


**Figure 10.** Relation of water level in selected wells completed in the principal aquifer in Salt Lake Valley to cumulative departure from average annual precipitation at Silver Lake near Brighton, and relation of water level in well (D-1-1)7abd-6 to concentration of chloride and dissolved solids in water from the well.

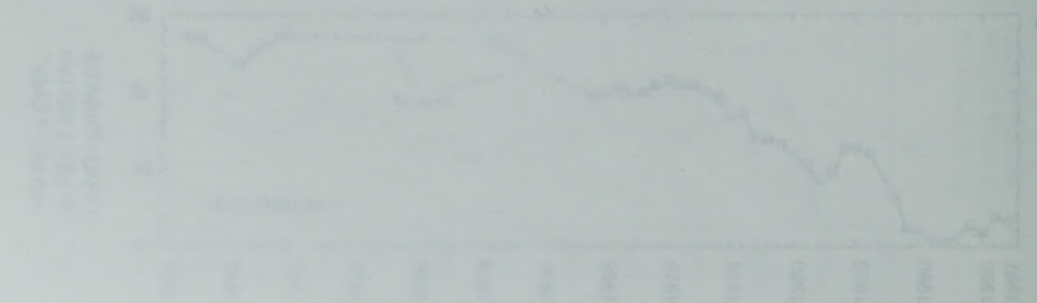
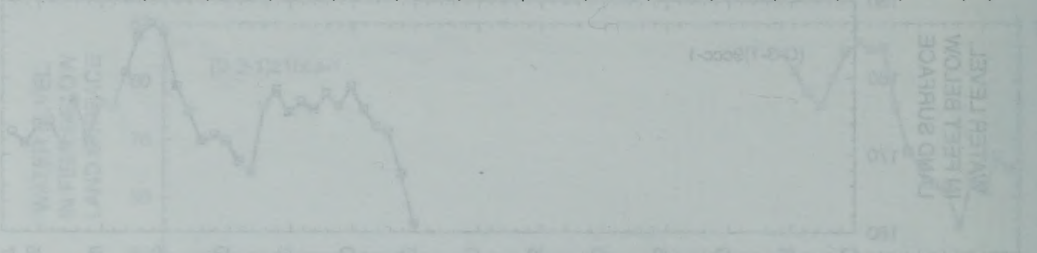
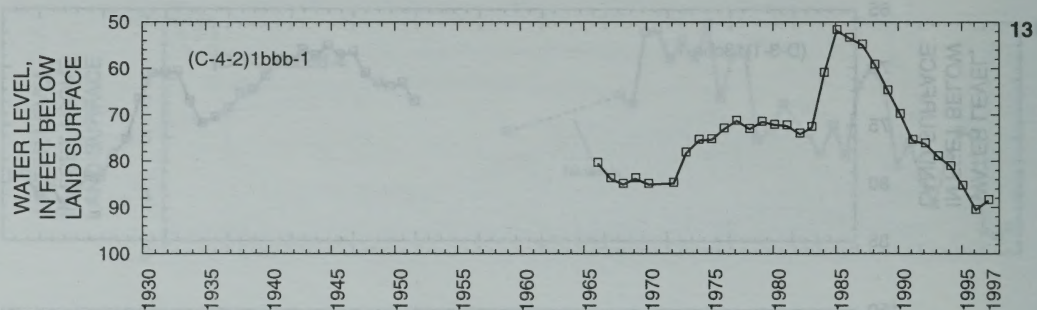
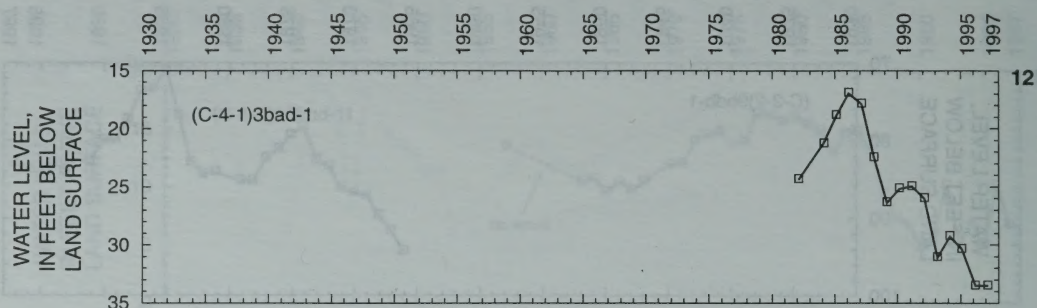


**Figure 10.** Relation of water level in selected wells completed in the principal aquifer in Salt Lake Valley to cumulative departure from average annual precipitation at Silver Lake near Brighton, and relation of water level in well (D-1-1)7abd-6 to concentration of chloride and dissolved solids in water from the well—Continued.



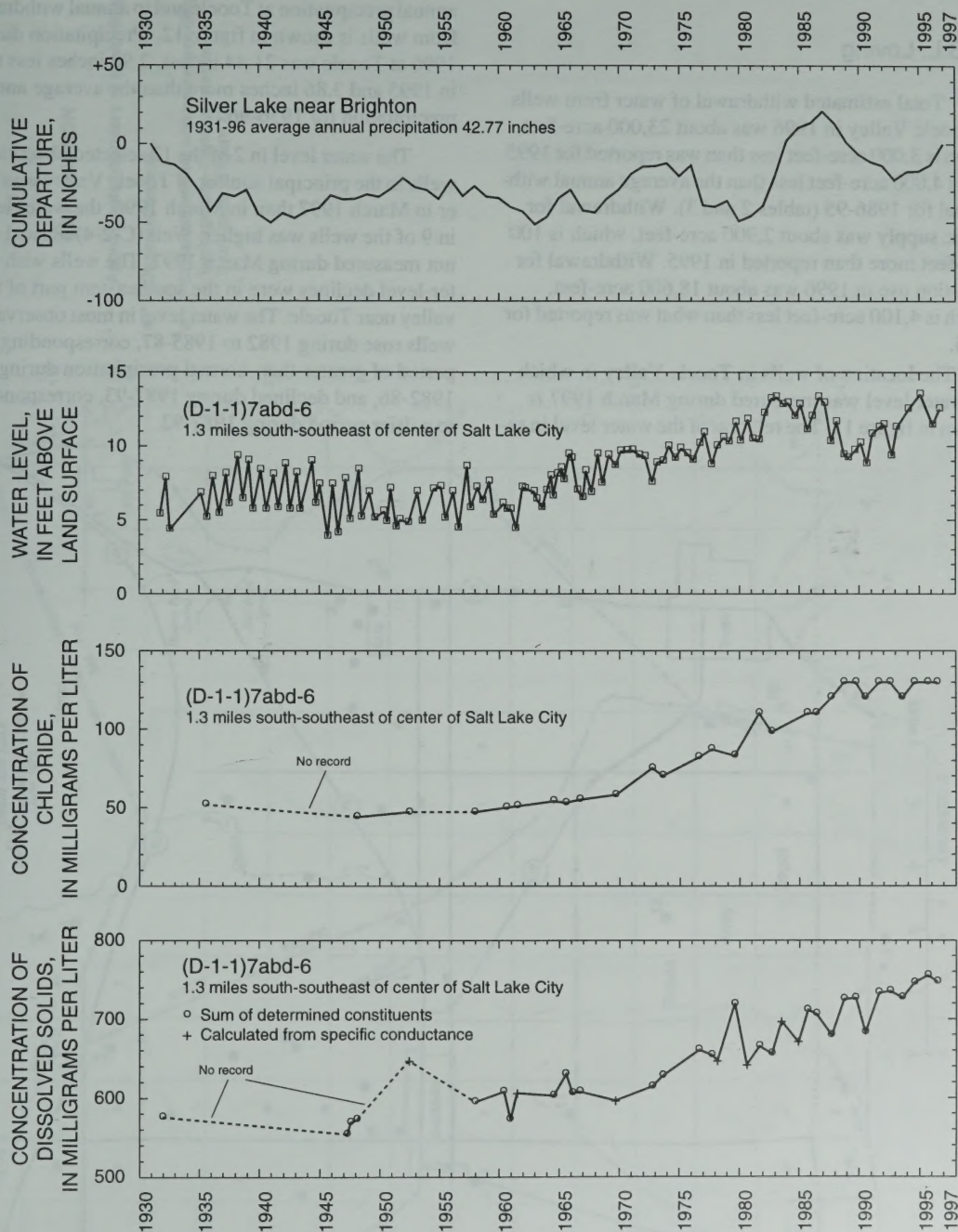


**Figure 10.** Relation of water level in selected wells completed in the principal aquifer in Salt Lake Valley to cumulative departure from average annual precipitation at Silver Lake near Brighton, and relation of water level in well (D-1-1)7abd-6 to concentration of chloride and dissolved solids in water from the well—Continued.



**Figure 10.** Relation of water level in selected wells completed in the principal aquifer in Salt Lake Valley to cumulative departure from average annual precipitation at Silver Lake near Brighton, and relation of water level in well (D-1-1)7abd-6 to concentration of chloride and dissolved solids in water from the well—Continued.





**Figure 10.** Relation of water level in selected wells completed in the principal aquifer in Salt Lake Valley to cumulative departure from average annual precipitation at Silver Lake near Brighton, and relation of water level in well (D-1-1)7abd-6 to concentration of chloride and dissolved solids in water from the well—Continued.

## TOOELE VALLEY

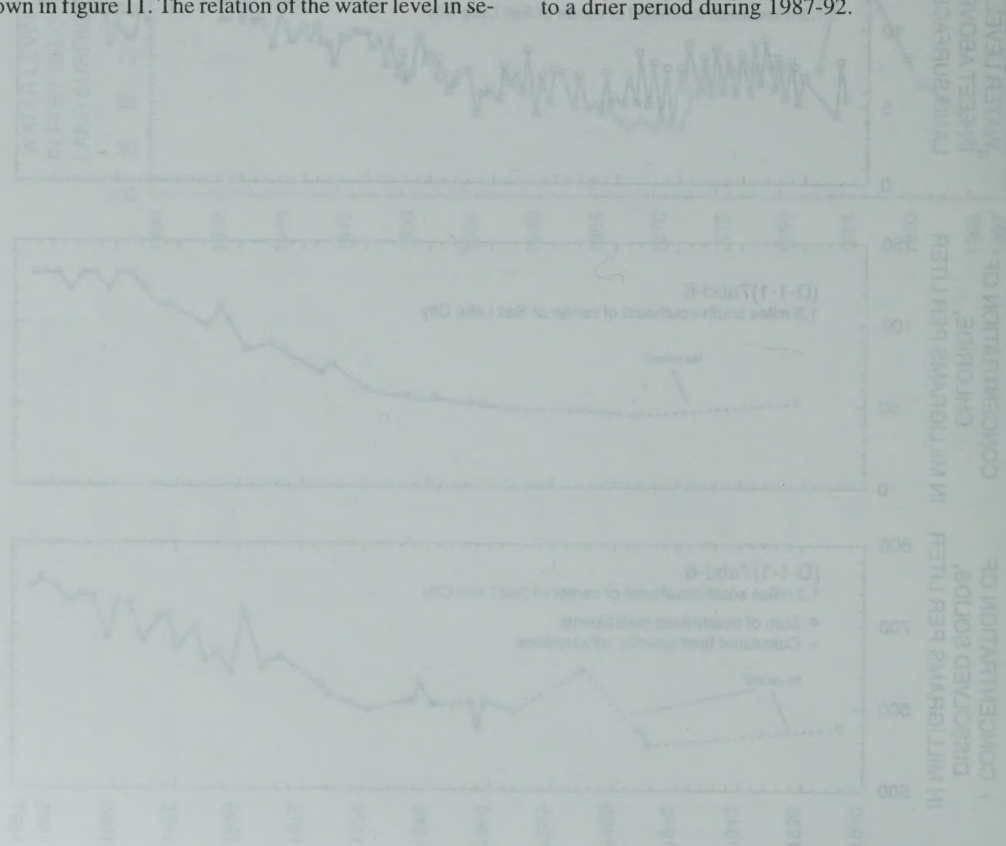
By B.L. Loving

Total estimated withdrawal of water from wells in Tooele Valley in 1996 was about 23,000 acre-feet, which is 3,000 acre-feet less than was reported for 1995 and is 4,000 acre-feet less than the average annual withdrawal for 1986-95 (tables 2 and 3). Withdrawal for public supply was about 2,900 acre-feet, which is 100 acre-feet more than reported in 1995. Withdrawal for irrigation use in 1996 was about 18,600 acre-feet, which is 4,100 acre-feet less than what was reported for 1995.

The location of wells in Tooele Valley in which the water level was measured during March 1997 is shown in figure 11. The relation of the water level in se-

lected wells to cumulative departure from the average annual precipitation at Tooele and to annual withdrawal from wells is shown in figure 12. Precipitation during 1996 at Tooele was 21.44 inches, 2.90 inches less than in 1995 and 3.86 inches more than the average annual precipitation for 1936-96.

The water level in 2 of the 12 selected observation wells in the principal aquifer of Tooele Valley was lower in March 1997 than in March 1996; the water level in 9 of the wells was higher. Well (C-2-4)28aac-1 was not measured during March 1997. The wells with water-level declines were in the southeastern part of the valley near Tooele. The water level in most observation wells rose during 1982 to 1985-87, corresponding to a period of greater-than-normal precipitation during 1982-86, and declined during 1987-93, corresponding to a drier period during 1987-92.





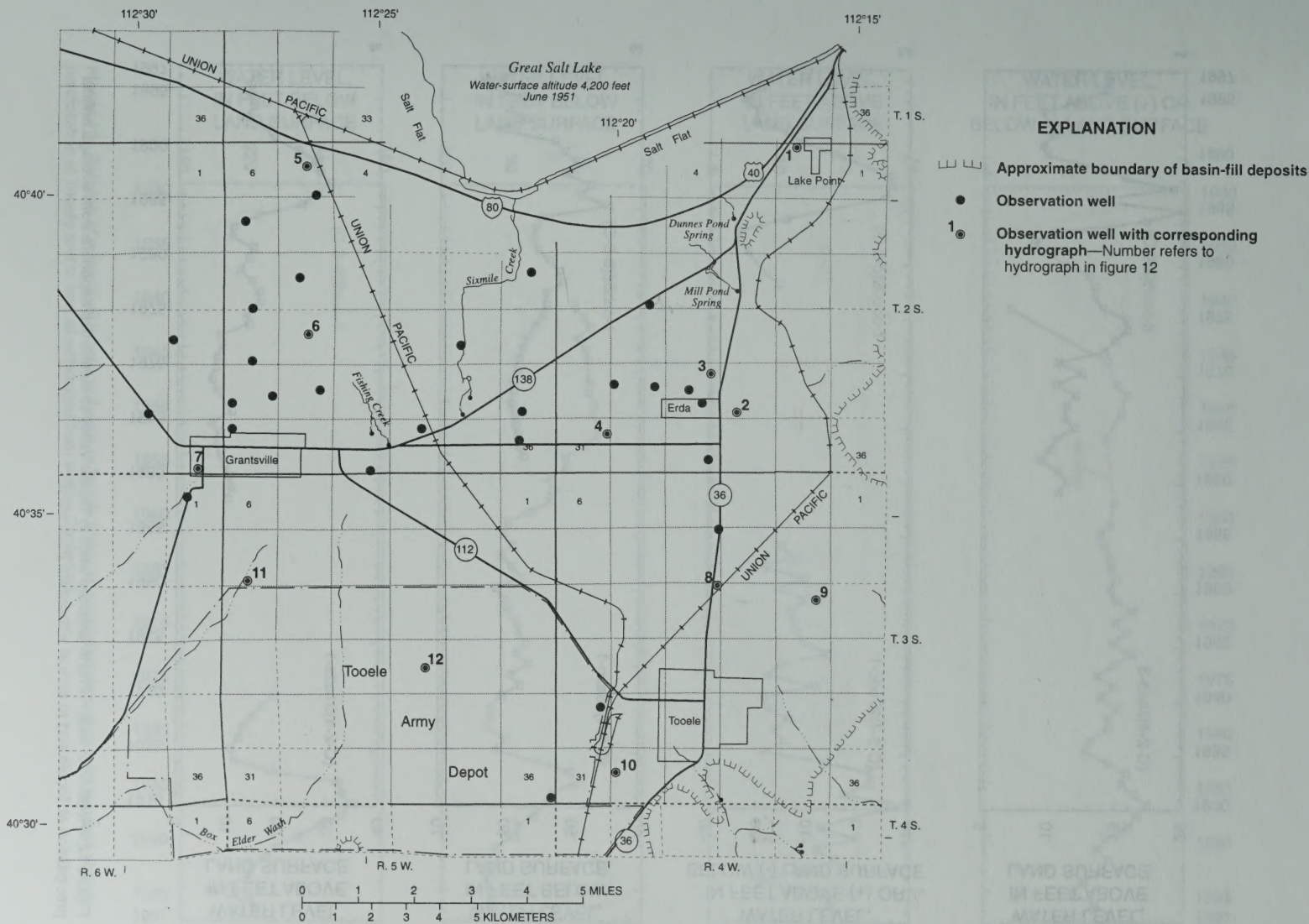


Figure 11. Location of wells in Tooele Valley in which the water level was measured during March 1997.

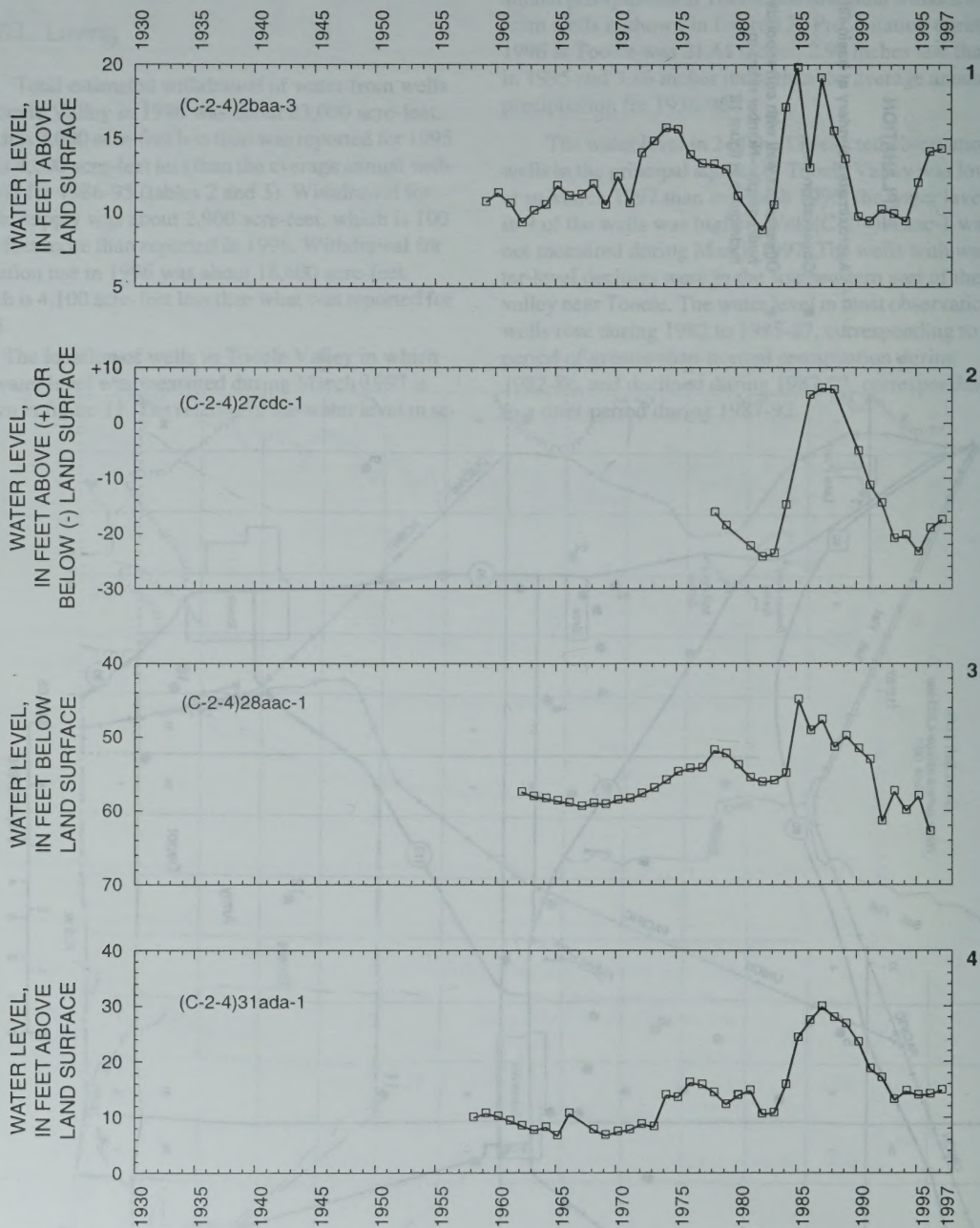
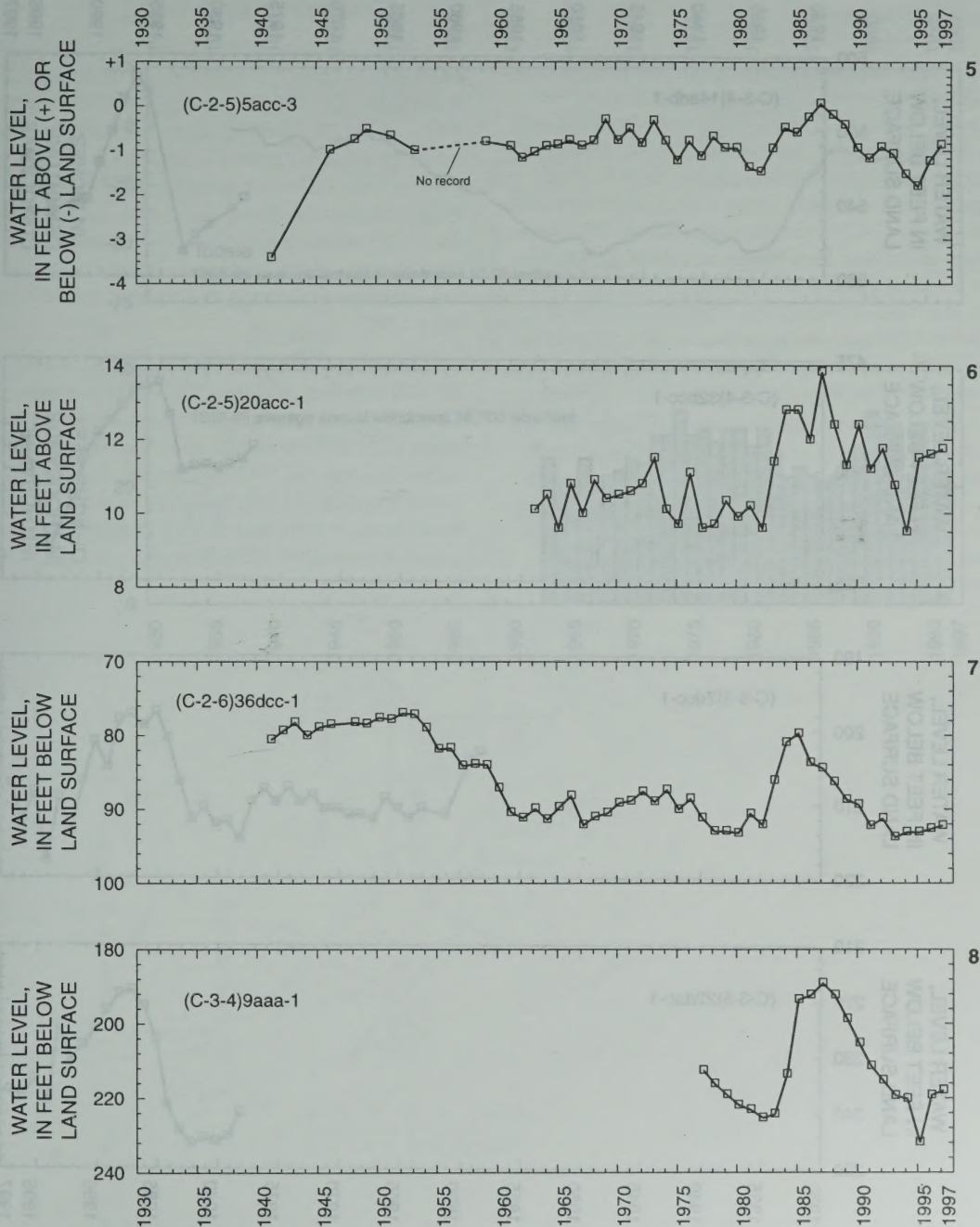


Figure 12. Relation of water level in selected wells in Tooele Valley to cumulative departure from average annual precipitation at Tooele and to annual withdrawal from wells.





**Figure 12.** Relation of water level in selected wells in Tooele Valley to cumulative departure from average annual precipitation at Tooele and to annual withdrawal from wells—Continued.

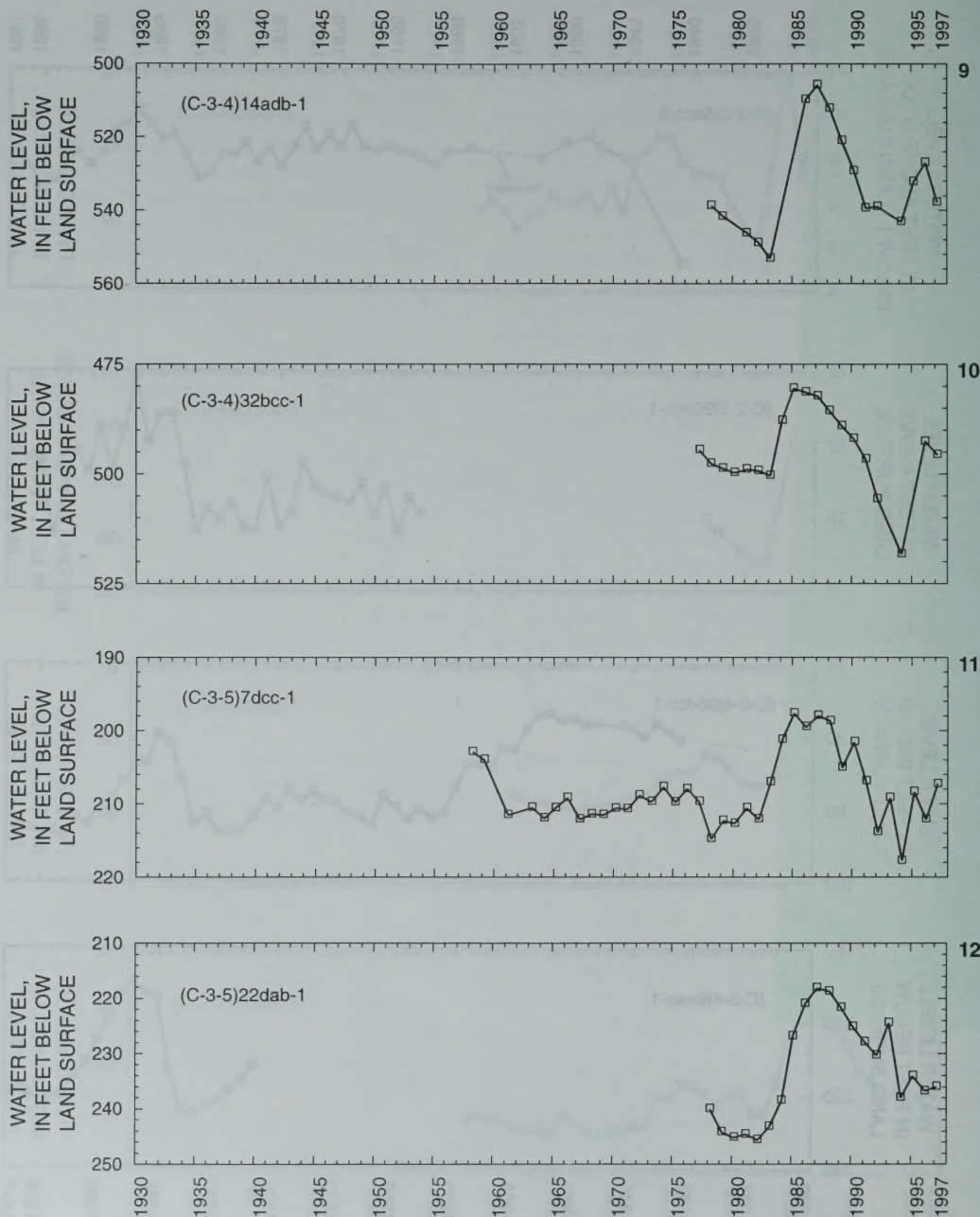
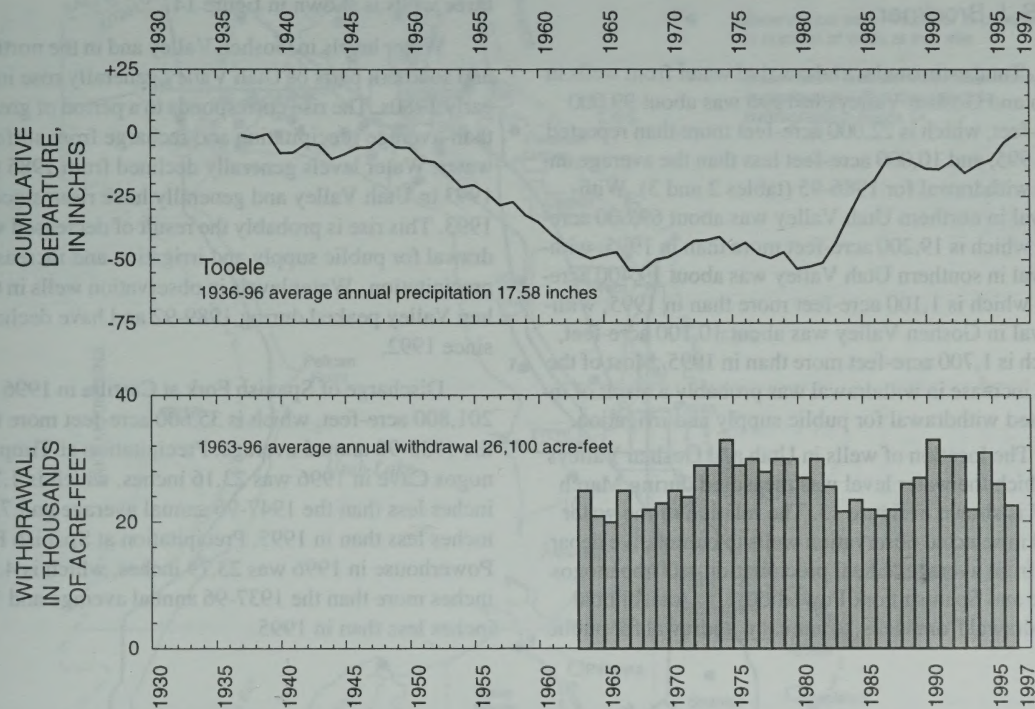


Figure 12. Relation of water level in selected wells in Tooele Valley to cumulative departure from average annual precipitation at Tooele and to annual withdrawal from wells—Continued.





**Figure 12.** Relation of water level in selected wells in Tooele Valley to cumulative departure from average annual precipitation at Tooele and to annual withdrawal from wells—Continued.

## UTAH AND GOSHEN VALLEYS

By S.J. Brockner

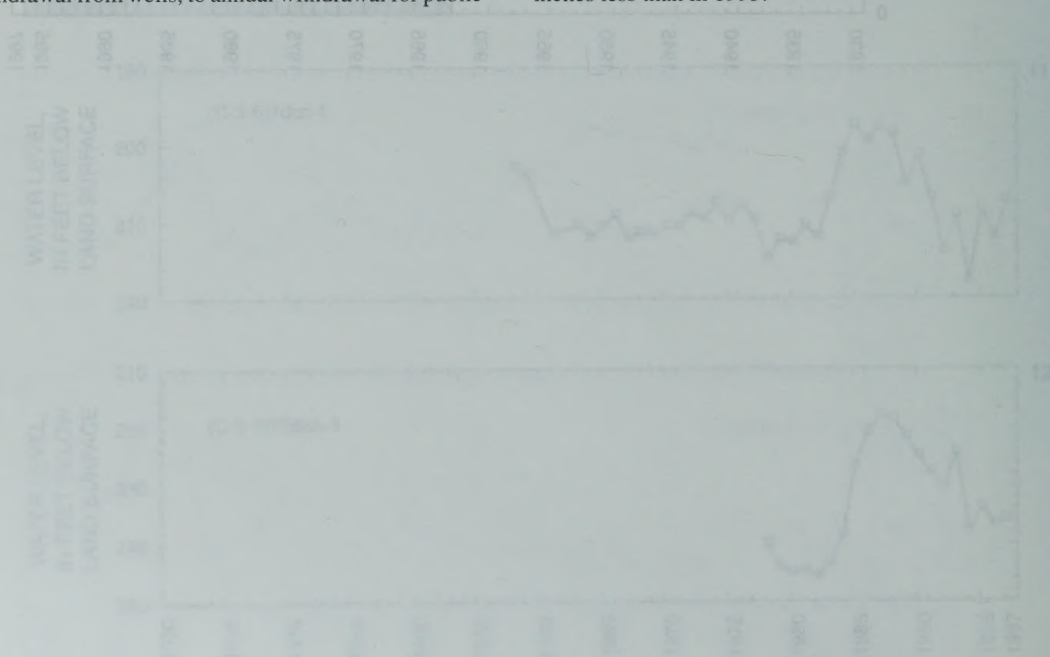
Total estimated withdrawal of water from wells in Utah and Goshen Valleys in 1996 was about 99,000 acre-feet, which is 22,000 acre-feet more than reported for 1995, and 10,000 acre-feet less than the average annual withdrawal for 1986-95 (tables 2 and 3). Withdrawal in northern Utah Valley was about 69,600 acre-feet, which is 19,200 acre-feet more than in 1995; withdrawal in southern Utah Valley was about 19,400 acre-feet, which is 1,100 acre-feet more than in 1995; withdrawal in Goshen Valley was about 10,100 acre-feet, which is 1,700 acre-feet more than in 1995. Most of the total increase in withdrawal was probably a result of increased withdrawal for public supply and irrigation.

The location of wells in Utah and Goshen Valleys in which the water level was measured during March 1997 is shown in figure 13. The relation of the water level in selected observation wells to cumulative departure from average annual precipitation at Timpanogos Cave and Spanish Fork Powerhouse, to total annual withdrawal from wells, to annual withdrawal for public

supply, to annual discharge of Spanish Fork at Castilla, and to concentration of dissolved solids in water from three wells is shown in figure 14.

Water levels in Goshen Valley and in the northern and southern parts of Utah Valley generally rose in the early 1980s. The rise corresponds to a period of greater-than-average precipitation and recharge from surface water. Water levels generally declined from 1985 to 1993 in Utah Valley and generally have risen since 1993. This rise is probably the result of decreased withdrawal for public supply and irrigation and increased precipitation. Water levels in observation wells in Goshen Valley peaked during 1989-92 and have declined since 1992.

Discharge of Spanish Fork at Castilla in 1996 was 201,800 acre-feet, which is 35,600 acre-feet more than the 1933-96 annual average. Precipitation at Timpanogos Cave in 1996 was 23.16 inches, which is 1.78 inches less than the 1947-96 annual average and 7.54 inches less than in 1995. Precipitation at Spanish Fork Powerhouse in 1996 was 23.79 inches, which is 4.39 inches more than the 1937-96 annual average and 1.33 inches less than in 1995.





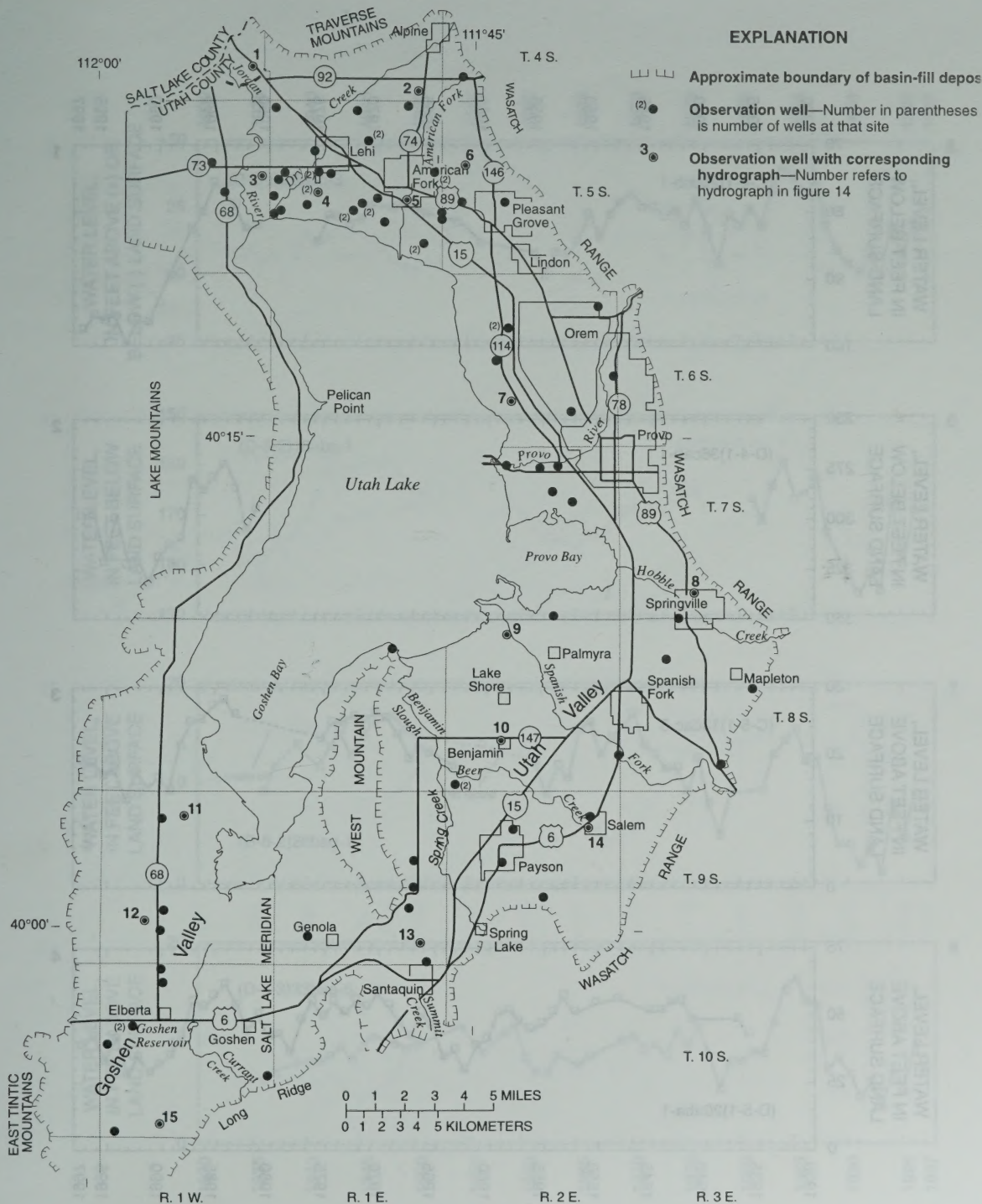
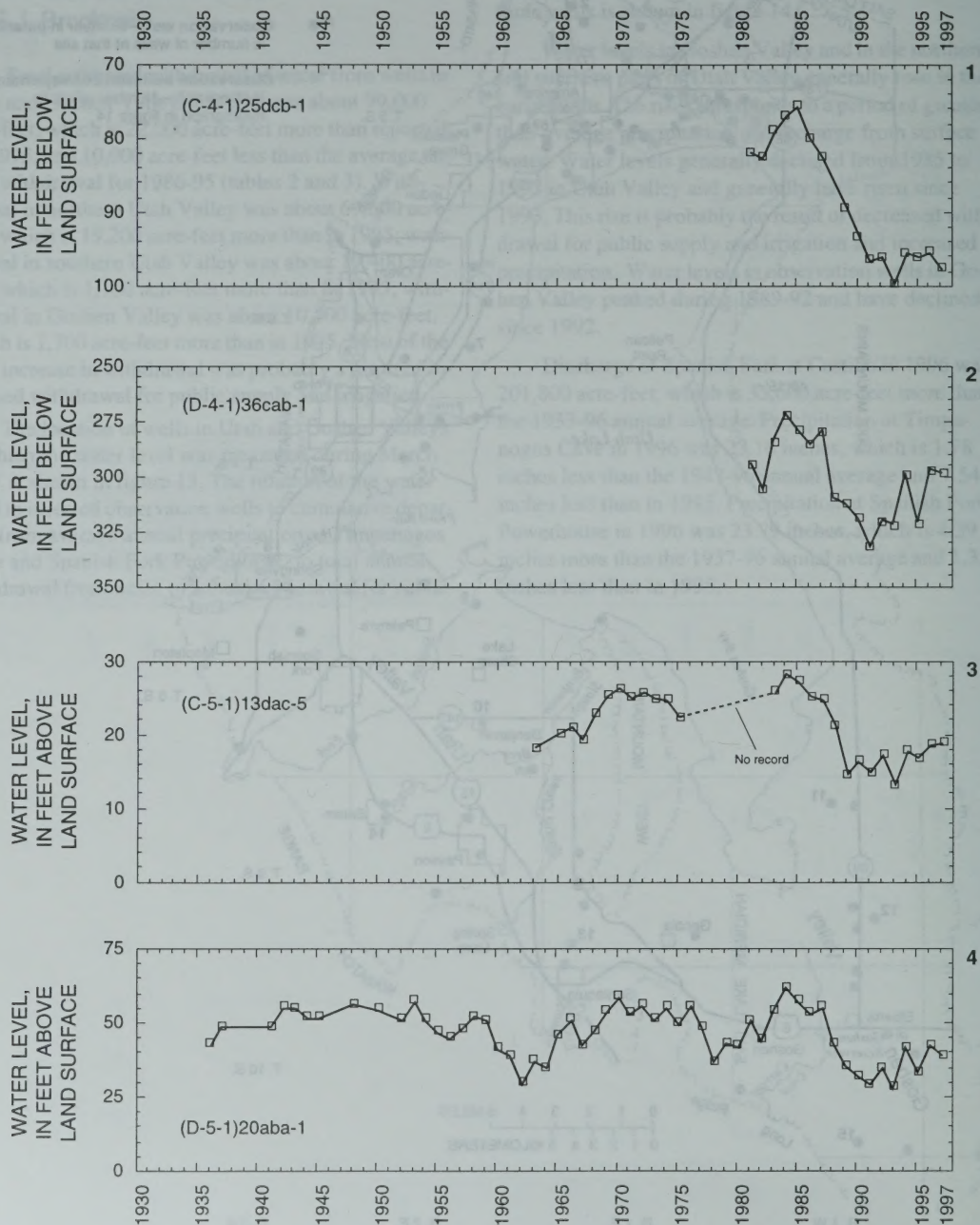
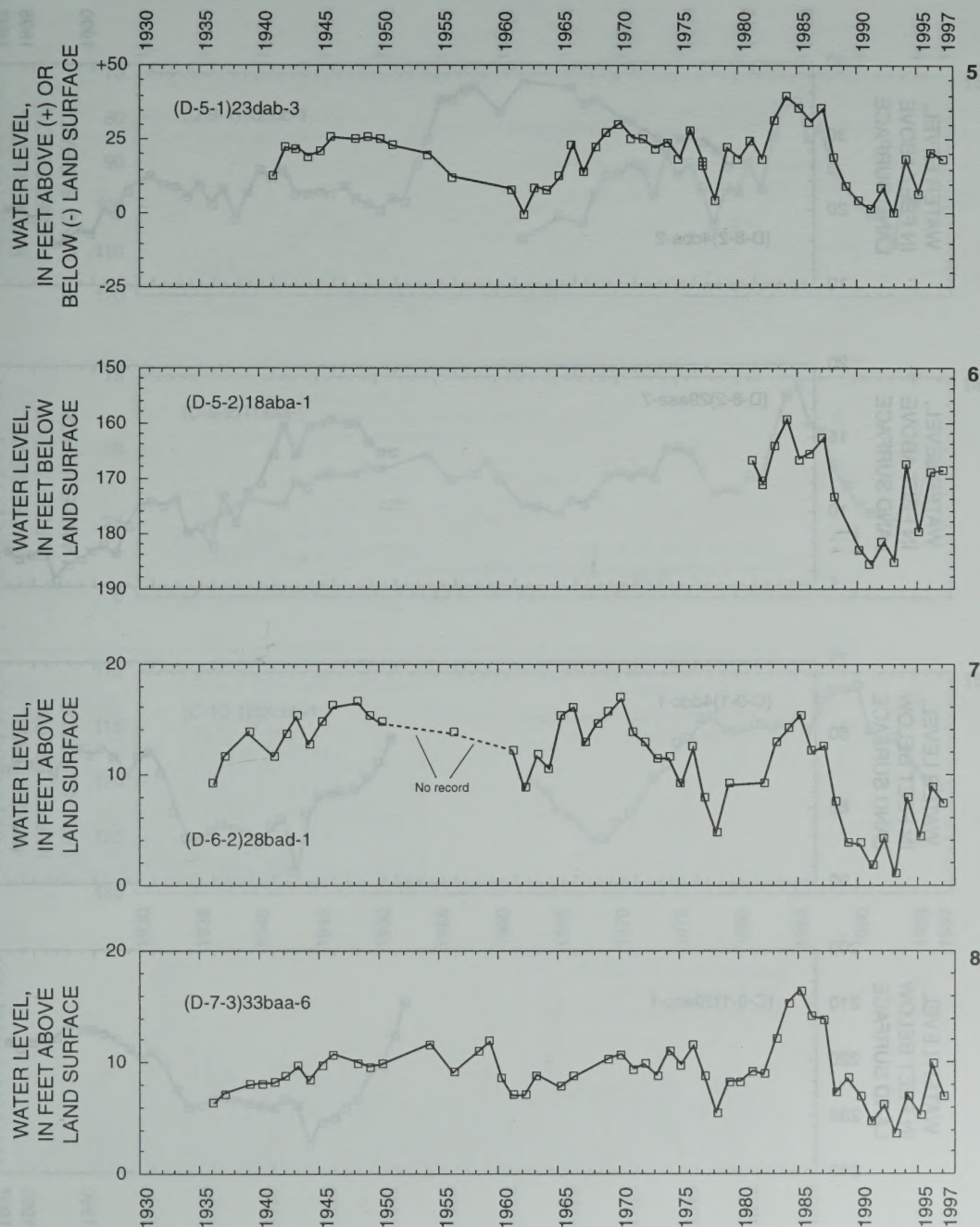


Figure 13. Location of wells in Utah and Goshen Valleys in which the water level was measured during March 1997.



**Figure 14.** Relation of water level in selected wells in Utah and Goshen Valleys to cumulative departure from average annual precipitation at Timpanogos Cave and Spanish Fork Powerhouse, to total annual withdrawal from wells, to annual withdrawal for public supply, to annual discharge of Spanish Fork at Castilla, and to concentration of dissolved solids in water from selected wells.





**Figure 14.** Relation of water level in selected wells in Utah and Goshen Valleys to cumulative departure from average annual precipitation at Timpanogos Cave and Spanish Fork Powerhouse, to total annual withdrawal from wells, to annual withdrawal for public supply, to annual discharge of Spanish Fork at Castilla, and to concentration of dissolved solids in water from selected wells—Continued.

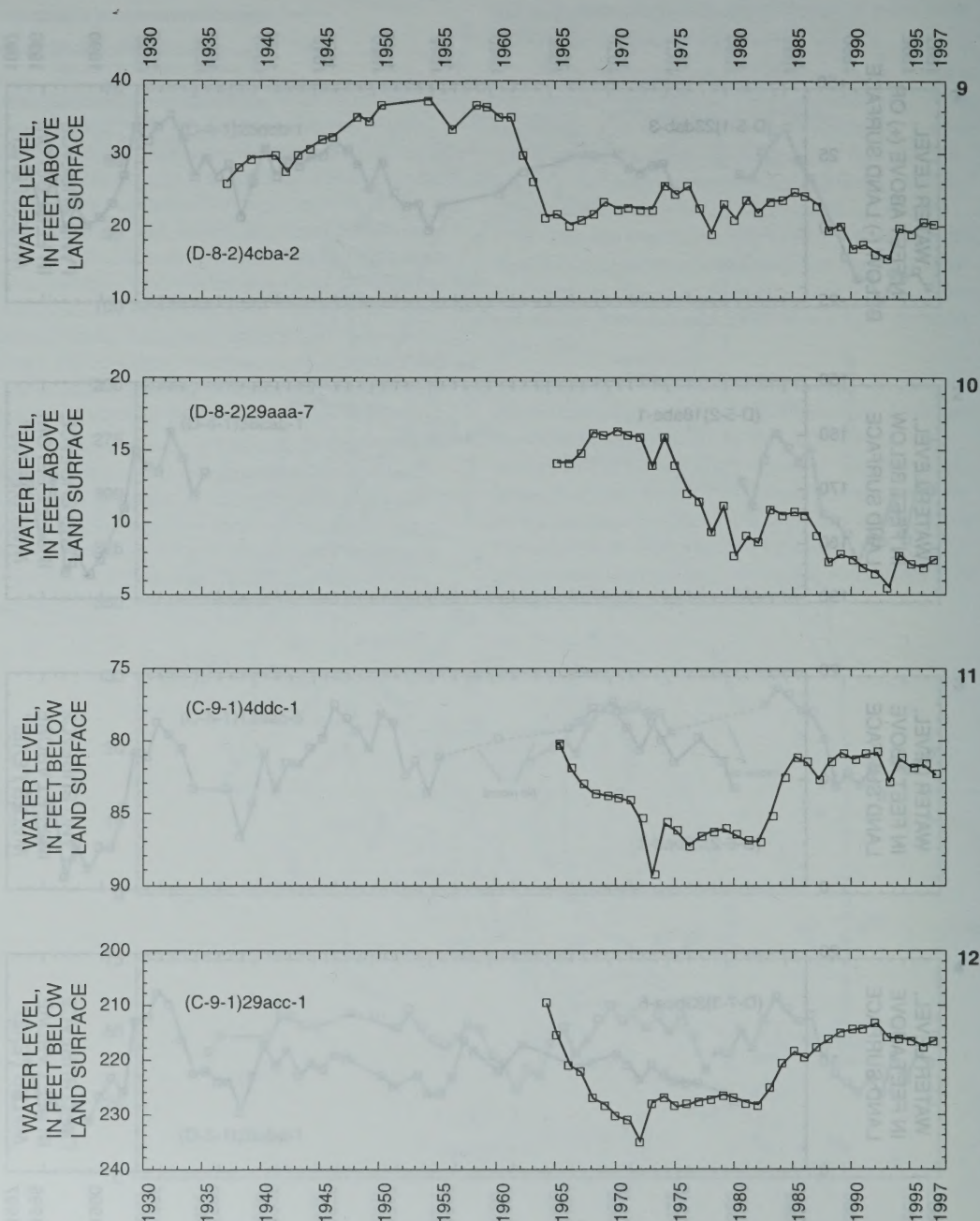
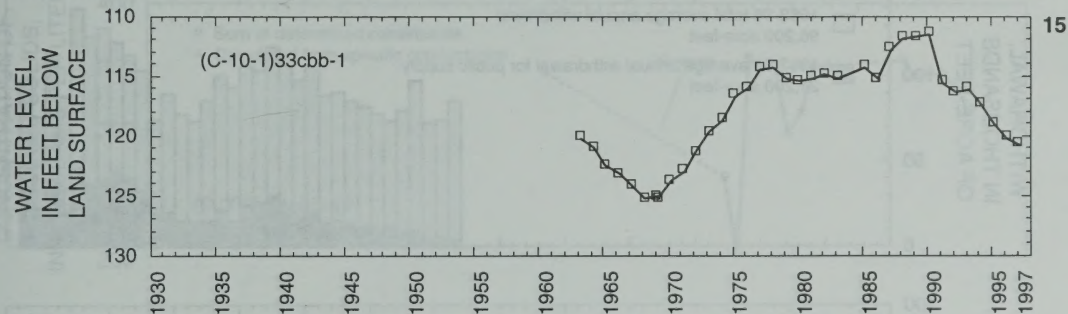
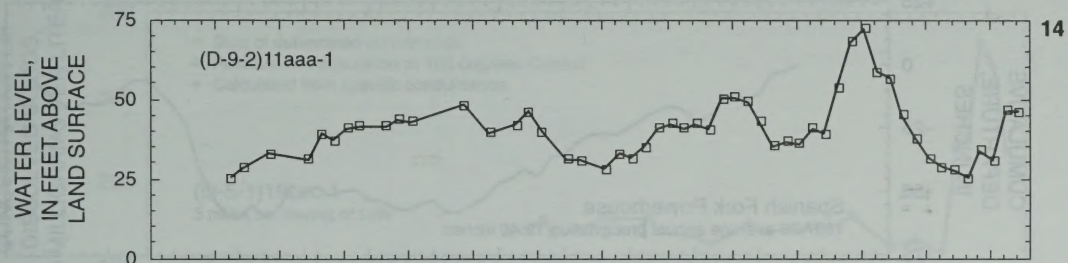
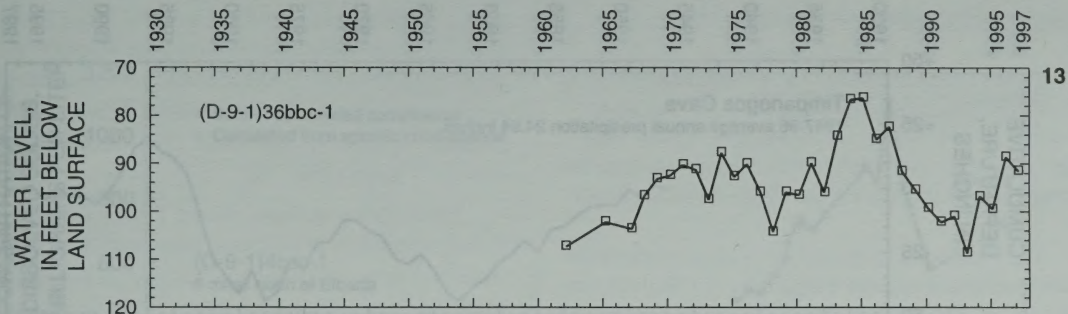
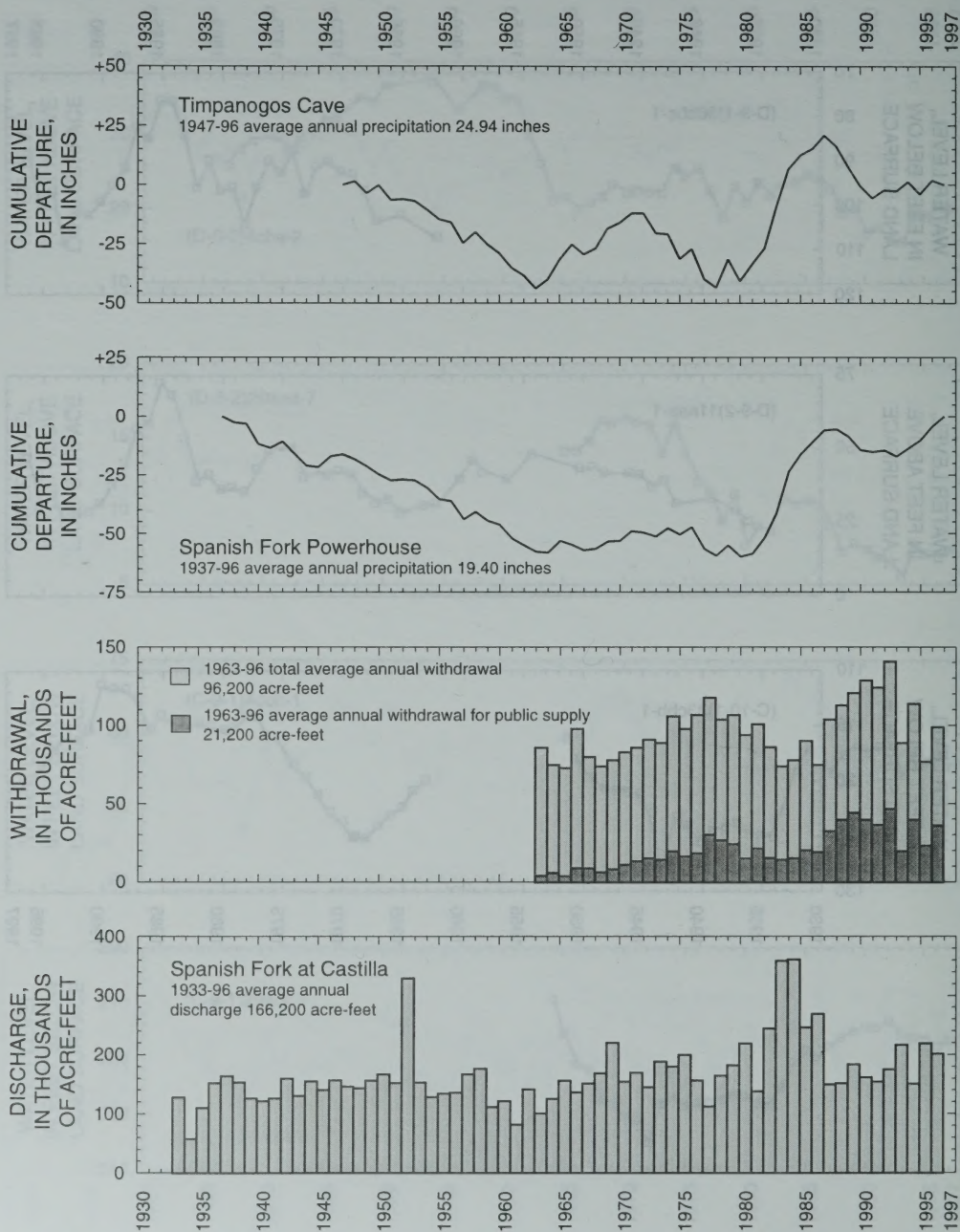


Figure 14. Relation of water level in selected wells in Utah and Goshen Valleys to cumulative departure from average annual precipitation at Timpanogos Cave and Spanish Fork Powerhouse, to total annual withdrawal from wells, to annual withdrawal for public supply, to annual discharge of Spanish Fork at Castilla, and to concentration of dissolved solids in water from selected wells—Continued.



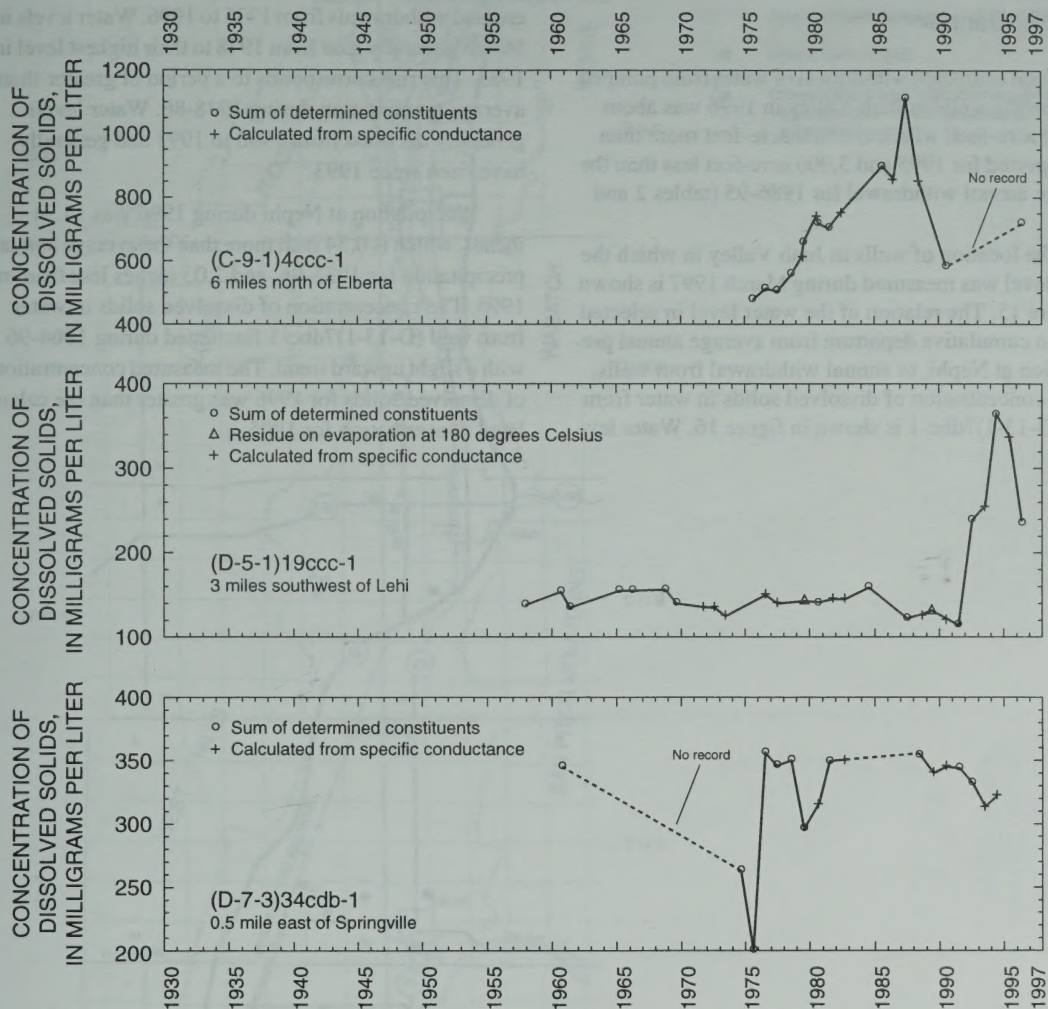


**Figure 14.** Relation of water level in selected wells in Utah and Goshen Valleys to cumulative departure from average annual precipitation at Timpanogos Cave and Spanish Fork Powerhouse, to total annual withdrawal from wells, to annual withdrawal for public supply, to annual discharge of Spanish Fork at Castilla, and to concentration of dissolved solids in water from selected wells—Continued.



**Figure 14.** Relation of water level in selected wells in Utah and Goshen Valleys to cumulative departure from average annual precipitation at Timpanogos Cave and Spanish Fork Powerhouse, to total annual withdrawal from wells, to annual withdrawal for public supply, to annual discharge of Spanish Fork at Castilla, and to concentration of dissolved solids in water from selected wells—Continued.





**Figure 14.** Relation of water level in selected wells in Utah and Goshen Valleys to cumulative departure from average annual precipitation at Timpanogos Cave and Spanish Fork Powerhouse, to total annual withdrawal from wells, to annual withdrawal for public supply, to annual discharge of Spanish Fork at Castilla, and to concentration of dissolved solids in water from selected wells—Continued.

## JUAB VALLEY

By M.R. Danner

Total estimated withdrawal of water from pumped and flowing wells in Juab Valley in 1996 was about 19,000 acre-feet, which is 6,000 acre-feet more than was reported for 1995 and 3,000 acre-feet less than the average annual withdrawal for 1986-95 (tables 2 and 3).

The location of wells in Juab Valley in which the water level was measured during March 1997 is shown in figure 15. The relation of the water level in selected wells to cumulative departure from average annual precipitation at Nephi, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (D-13-1)7dbc-1 is shown in figure 16. Water lev-

els in March declined in 7 of 10 observations wells in Juab Valley from 1996 to 1997, probably because of increased withdrawals from 1995 to 1996. Water levels in March generally rose from 1978 to their highest level in 1985. This rise corresponds to a period of greater-than-average precipitation during 1978-86. Water levels generally declined from 1986 to 1993 and generally have risen since 1993.

Precipitation at Nephi during 1996 was 14.94 inches, which is 0.54 inch more than the average annual precipitation for 1935-96, and 2.03 inches less than in 1995. The concentration of dissolved solids in water from well (D-13-1)7dbc-1 fluctuated during 1964-96 with a slight upward trend. The measured concentration of dissolved solids for 1996 was greater than the calculated concentration for 1995.





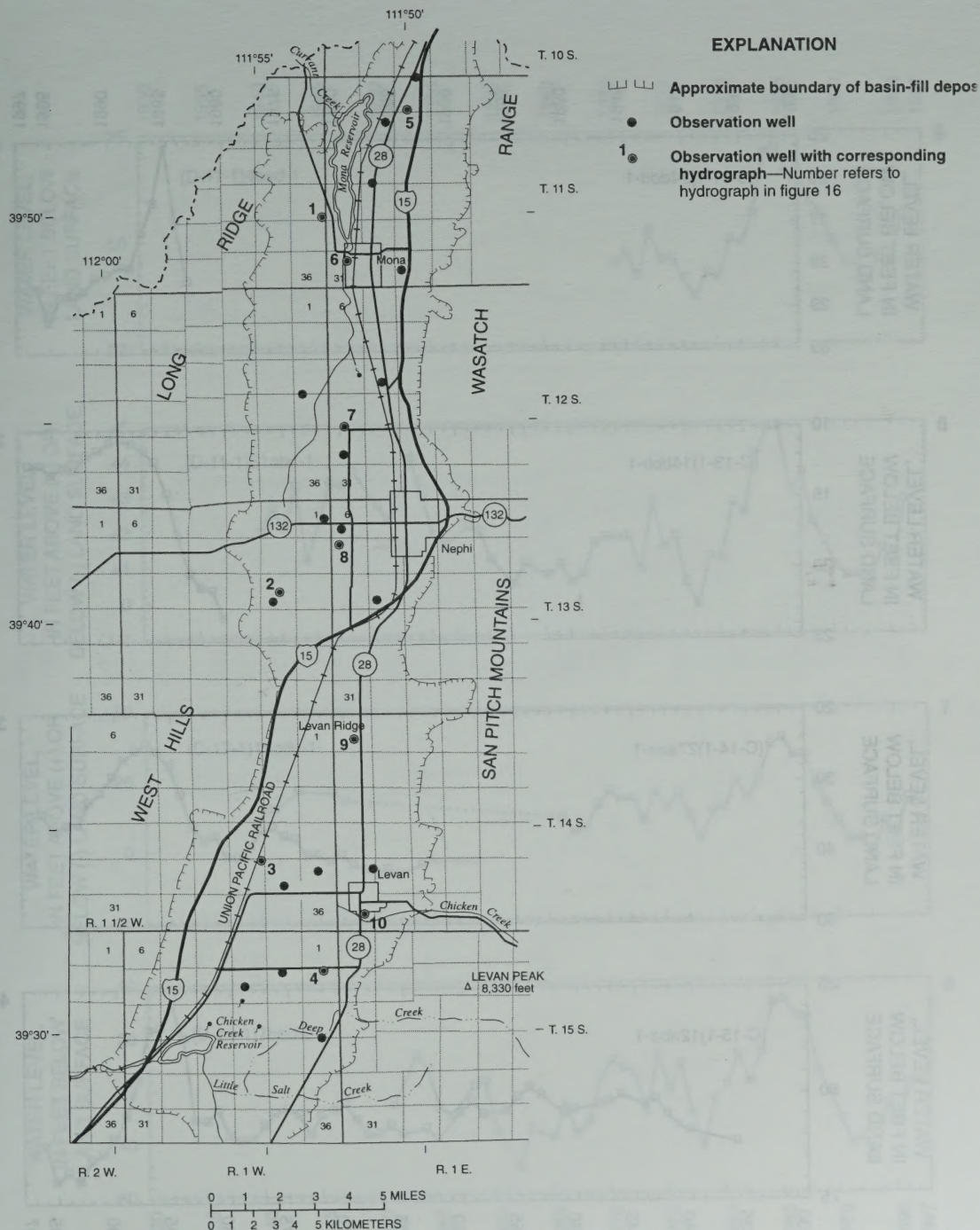
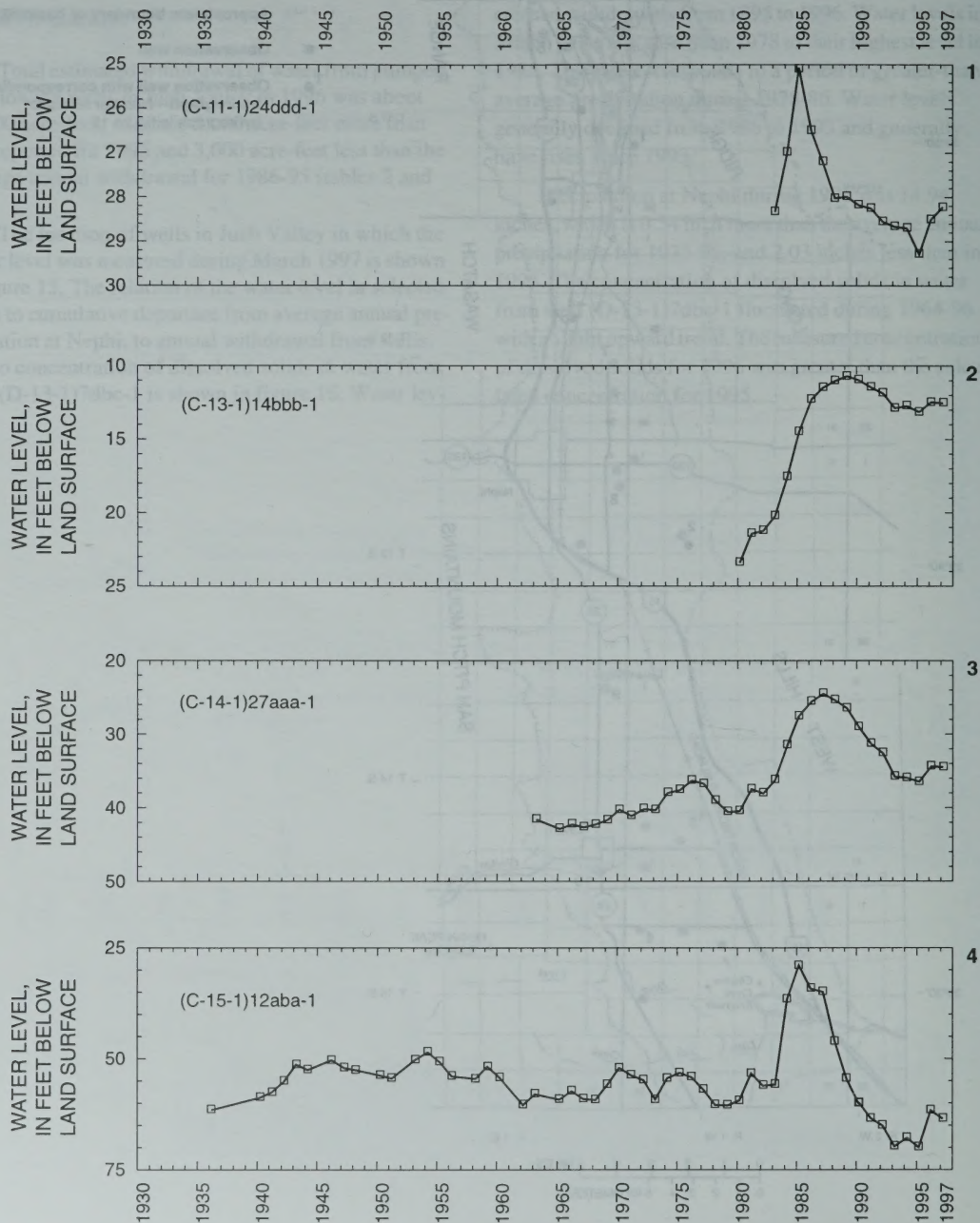
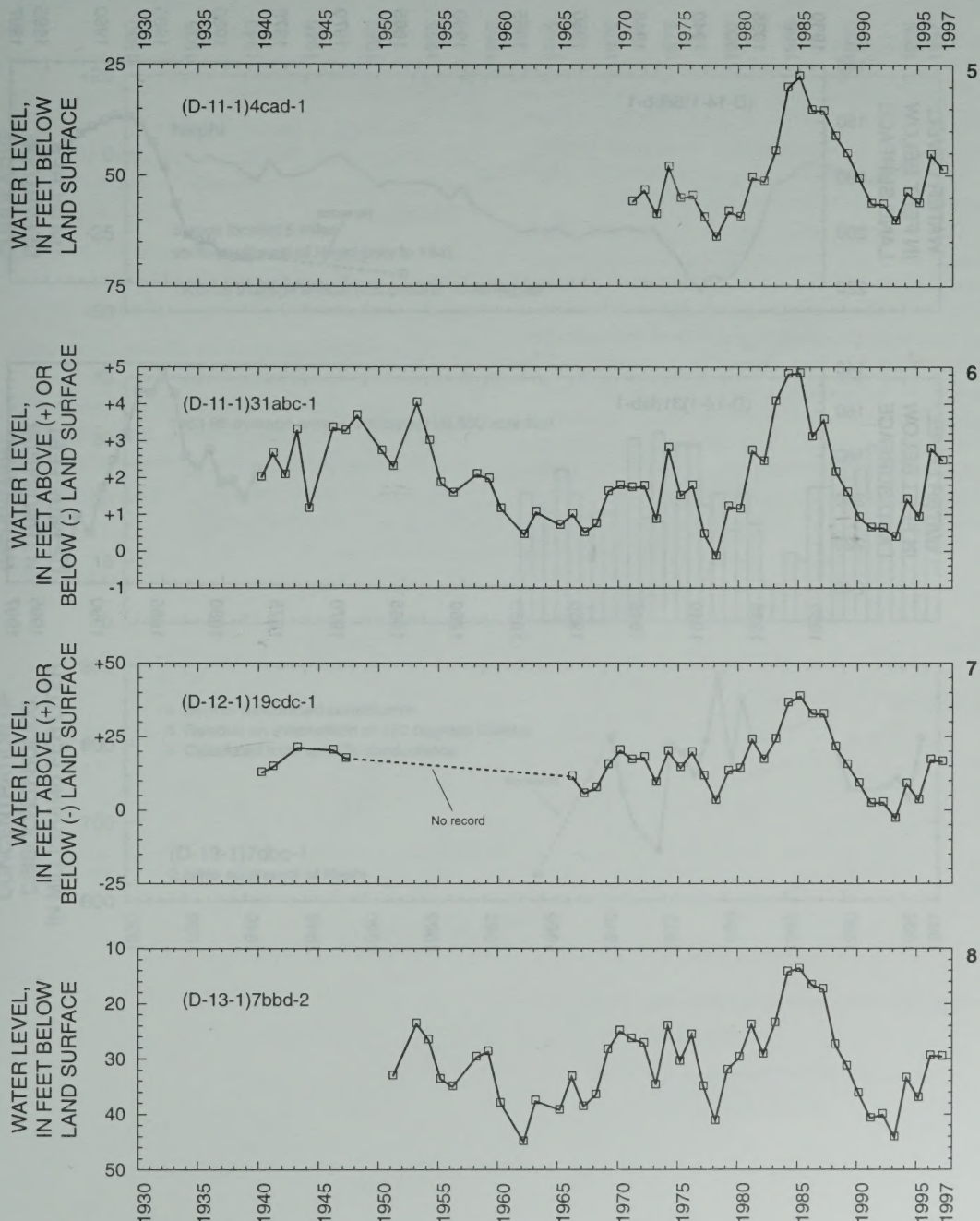


Figure 15. Location of wells in Juab Valley in which the water level was measured during March 1997.

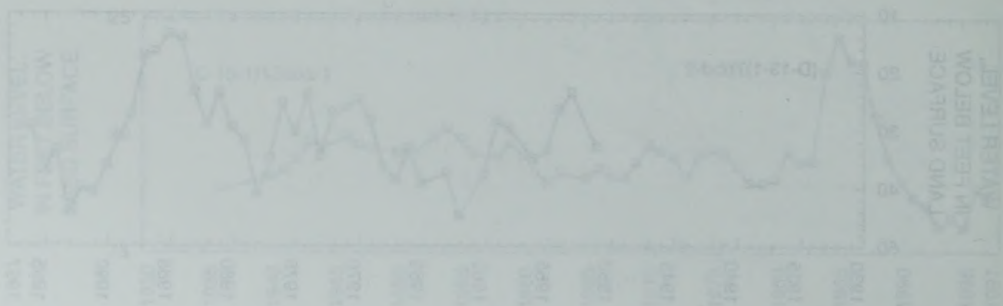
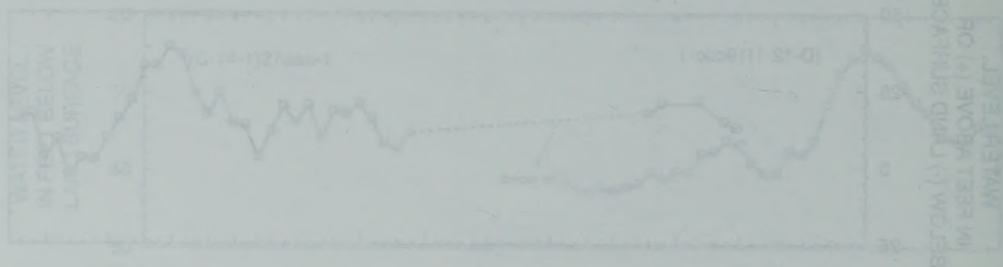
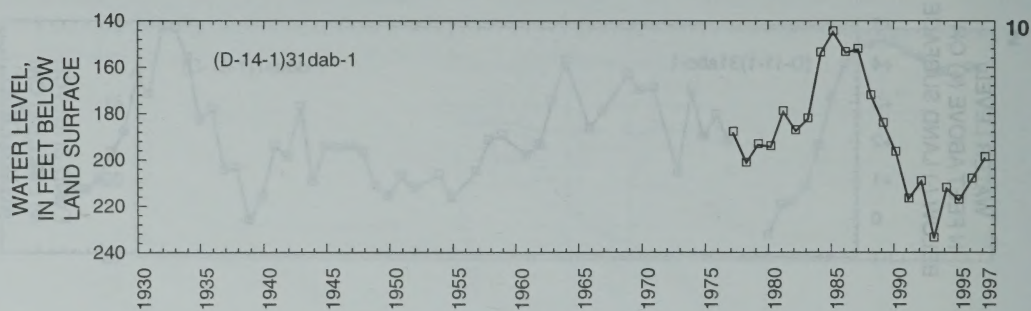
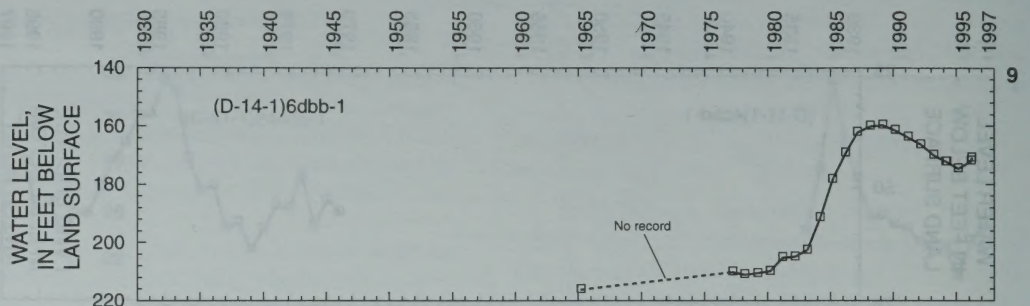


**Figure 16.** Relation of water level in selected wells in Juab Valley to cumulative departure from average annual precipitation at Nephi, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (D-13-1)7dbc-1.



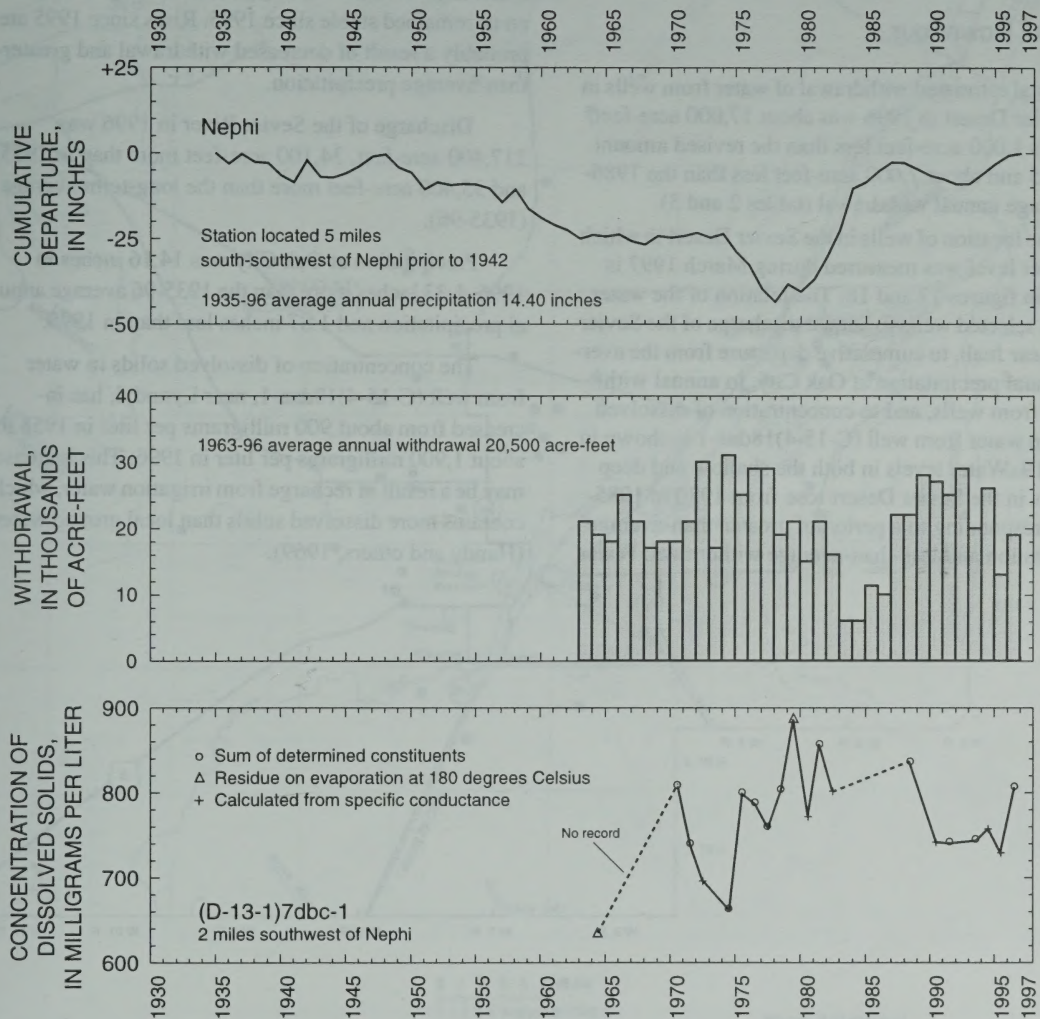


**Figure 16.** Relation of water level in selected wells in Juab Valley to cumulative departure from average annual precipitation at Nephi, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (D-13-1)7dbc-1—Continued.



**Figure 16.** Relation of water level in selected wells in Juab Valley to cumulative departure from average annual precipitation at Nephi, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (D-13-1)7dbc-1—Continued.





**Figure 16.** Relation of water level in selected wells in Juab Valley to cumulative departure from average annual precipitation at Nephi, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (D-13-1)7dbc-1—Continued.

## SEVIER DESERT

By Paul Downhour

Total estimated withdrawal of water from wells in the Sevier Desert in 1996 was about 17,000 acre-feet, which is 1,000 acre-feet less than the revised amount for 1995 and about 7,000 acre-feet less than the 1986-95 average annual withdrawal (tables 2 and 3).

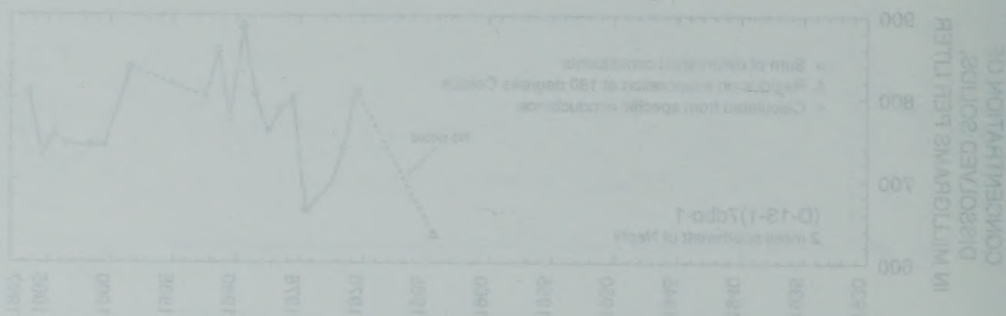
The location of wells in the Sevier Desert in which the water level was measured during March 1997 is shown in figures 17 and 18. The relation of the water level in selected wells to annual discharge of the Sevier River near Juab, to cumulative departure from the average annual precipitation at Oak City, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-15-4)18daa-1 is shown in figure 19. Water levels in both the shallow and deep aquifers in the Sevier Desert rose from 1980 to 1985-88, corresponding to a period of greater-than-average precipitation and less-than-average withdrawal. Water

levels in both aquifers began declining during 1987-90, continued to decline until 1995, and have generally risen or remained stable since 1995. Rises since 1995 are probably a result of decreased withdrawal and greater-than-average precipitation.

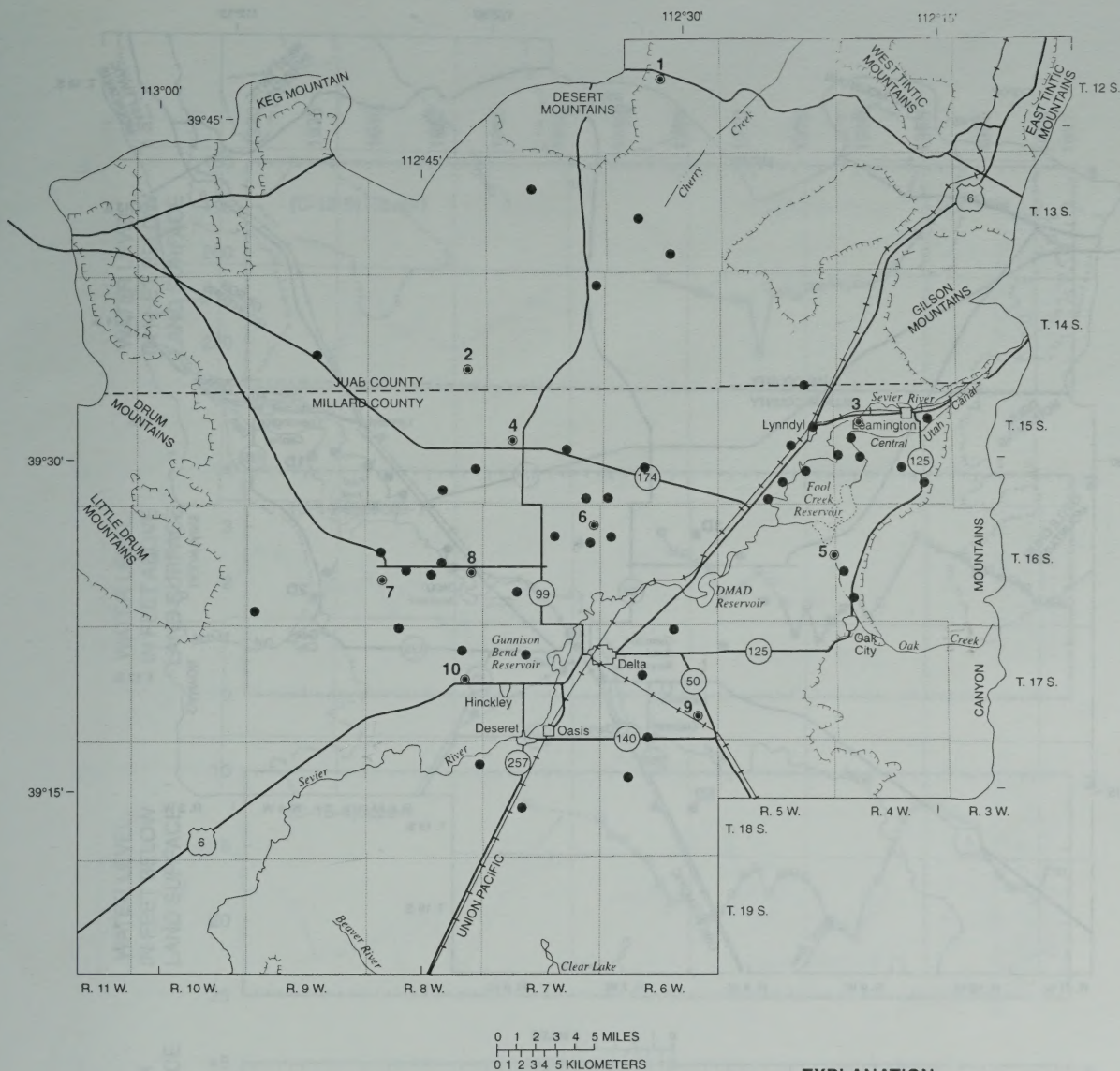
Discharge of the Sevier River in 1996 was 217,400 acre-feet, 34,100 acre-feet more than in 1995 and 35,400 acre-feet more than the long-term average (1935-96).

Precipitation at Oak City was 14.16 inches in 1996, 1.33 inches more than the 1935-96 average annual precipitation and 1.87 inches less than in 1995.

The concentration of dissolved solids in water from well (C-15-4)18daa-1, near Lynndyl, has increased from about 900 milligrams per liter in 1958 to about 1,900 milligrams per liter in 1996. This increase may be a result of recharge from irrigation water, which contains more dissolved solids than local ground water (Handy and others, 1969).



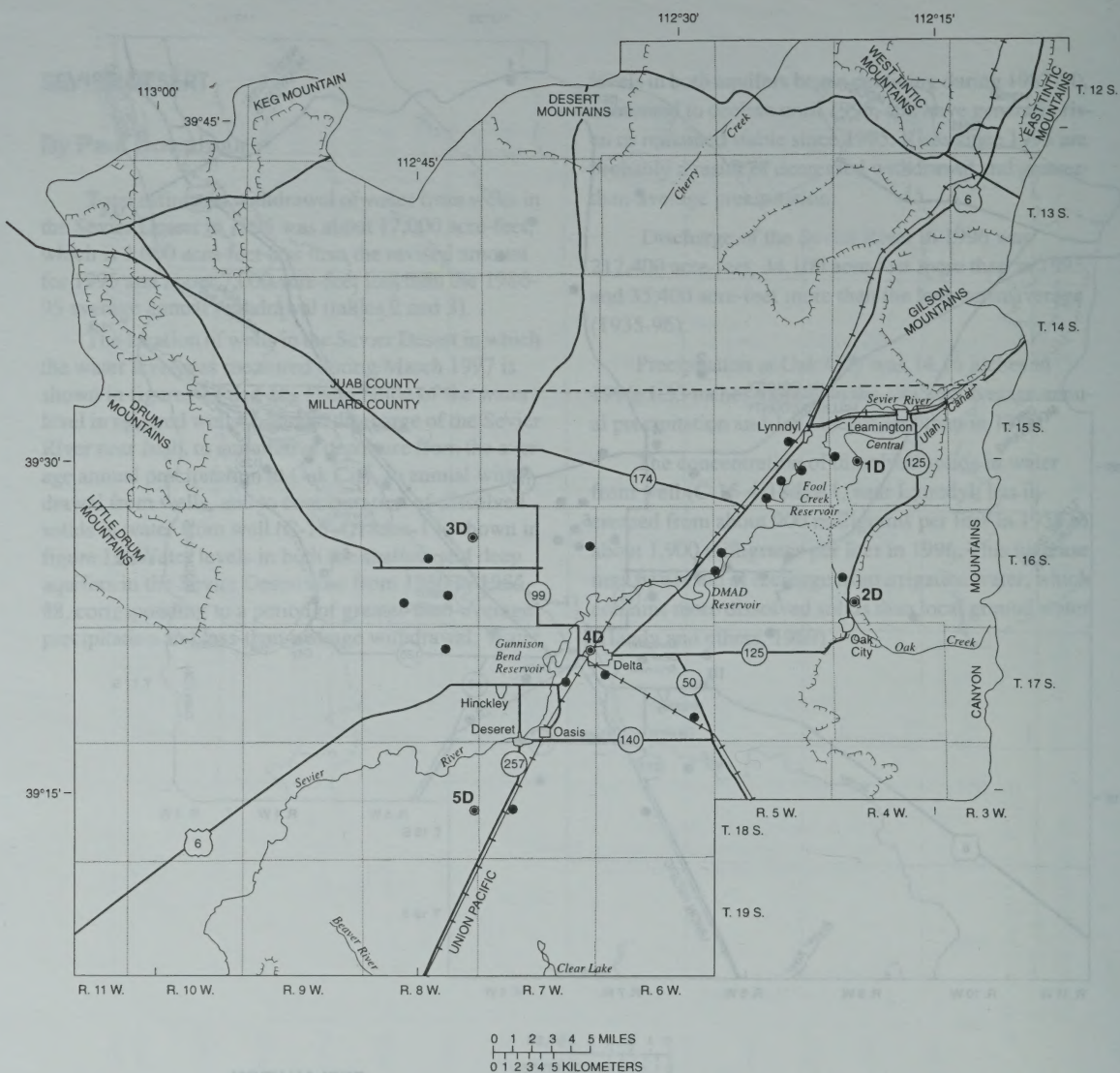




#### EXPLANATION

- Approximate boundary of basin-fill deposits
- Observation well
- Observation well with corresponding hydrograph—Number refers to hydrograph in figure 19

**Figure 17.** Location of wells in part of the Sevier Desert in which the water level was measured during March 1997 in the shallow artesian aquifer.

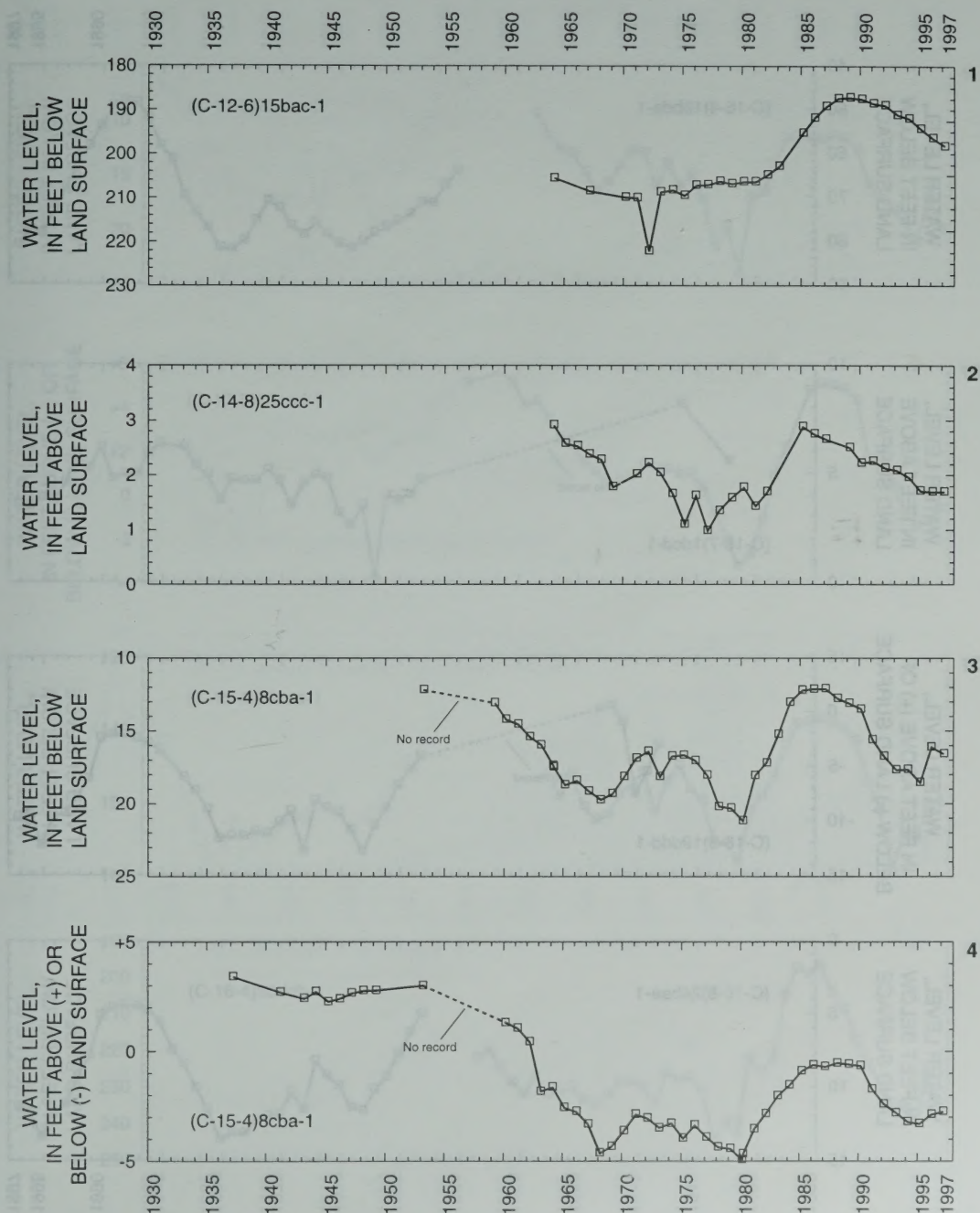


#### EXPLANATION

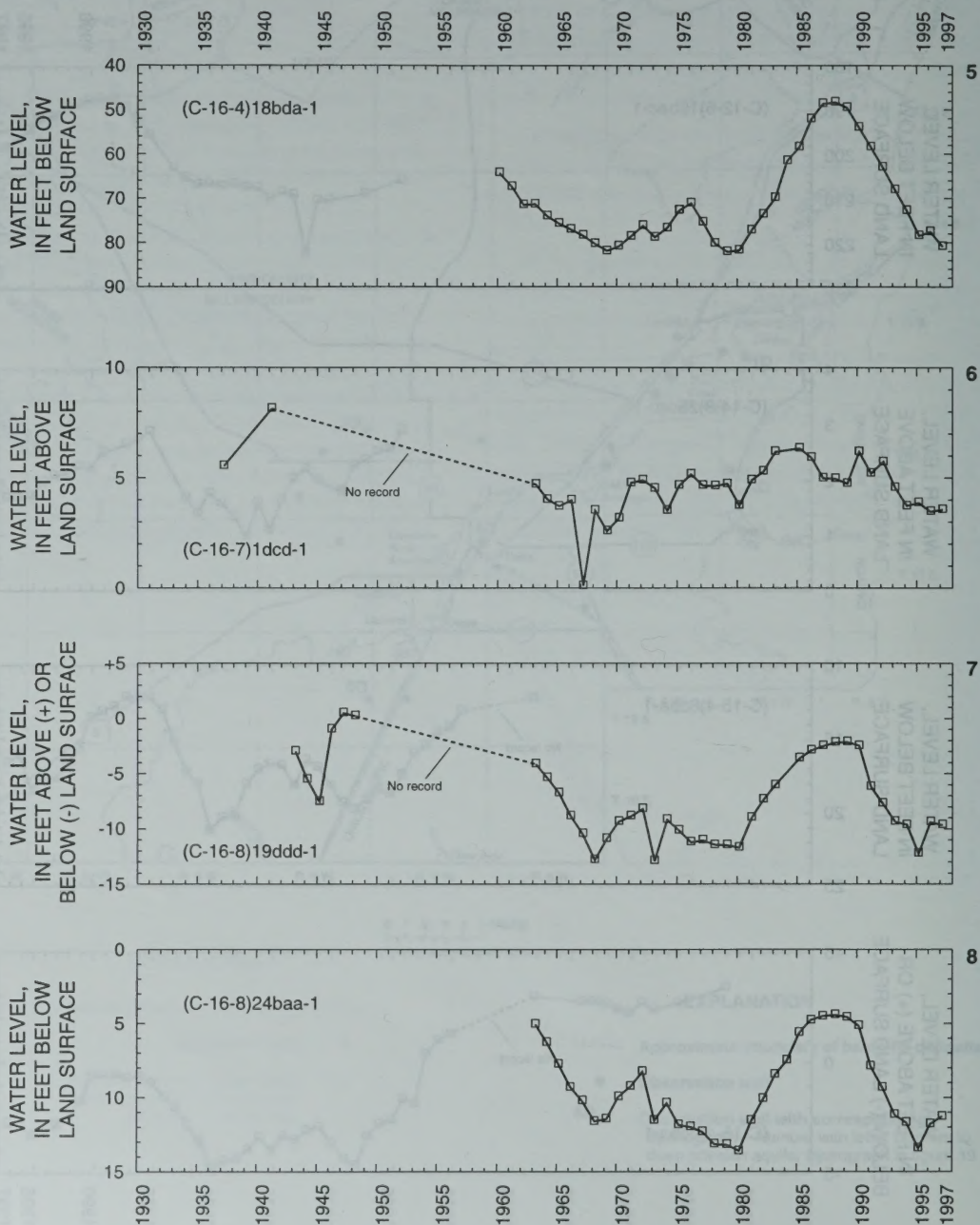
- Approximate boundary of basin-fill deposits
- Observation well
- Observation well with corresponding hydrograph—Number with letter D refers to deep artesian aquifer hydrograph in figure 19

Figure 18. Location of wells in part of the Sevier Desert in which the water level was measured during March 1997 in the deep artesian aquifer.



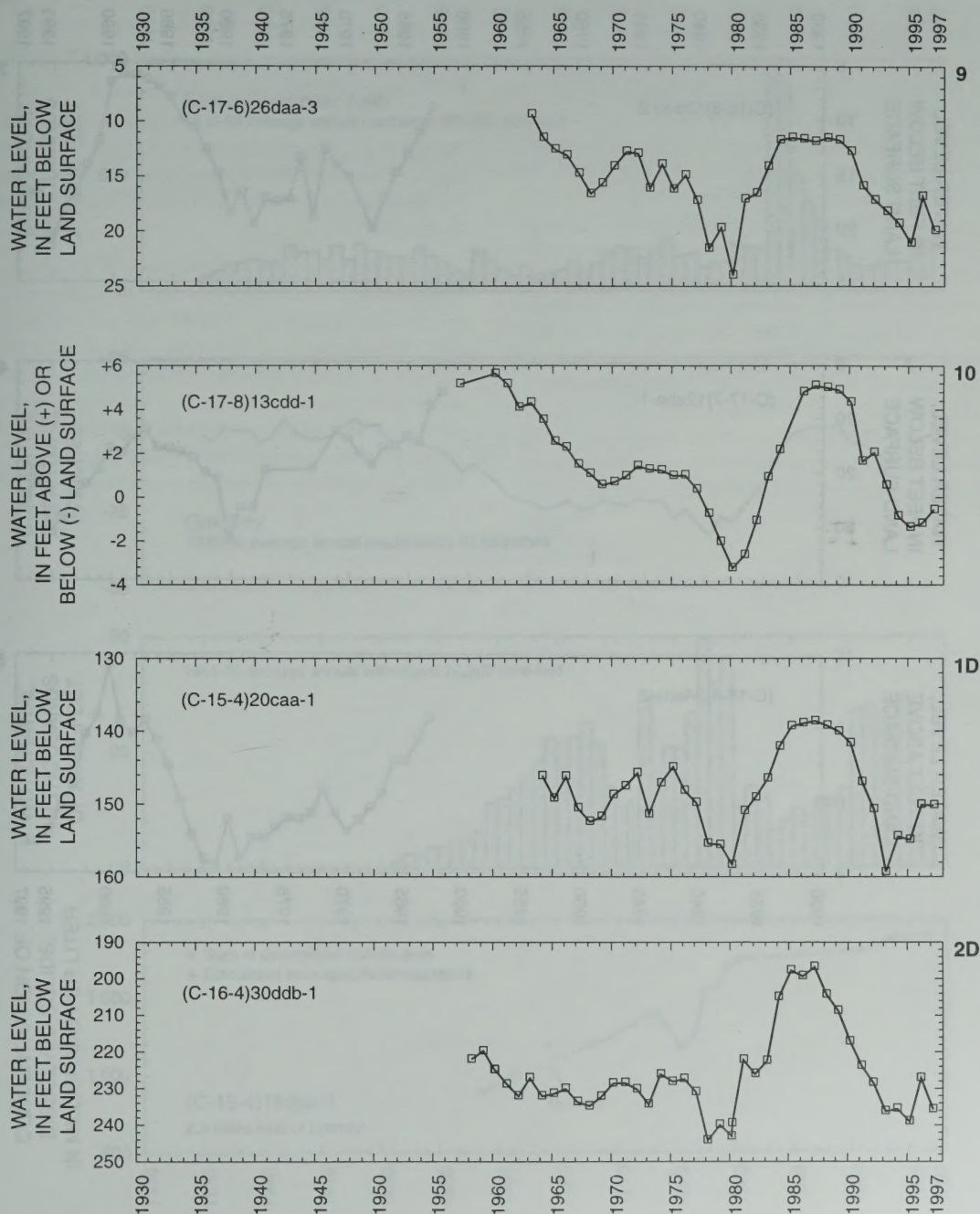


**Figure 19.** Relation of water level in selected wells in the Sevier Desert to annual discharge of the Sevier River near Juab, to cumulative departure from average annual precipitation at Oak City, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-15-4)18daa-1.



**Figure 19.** Relation of water level in selected wells in the Sevier Desert to annual discharge of the Sevier River near Juab, to cumulative departure from average annual precipitation at Oak City, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-15-4)18daa-1—Continued.





**Figure 19.** Relation of water level in selected wells in the Sevier Desert to annual discharge of the Sevier River near Juab, to cumulative departure from average annual precipitation at Oak City, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-15-4)18daa-1—Continued.

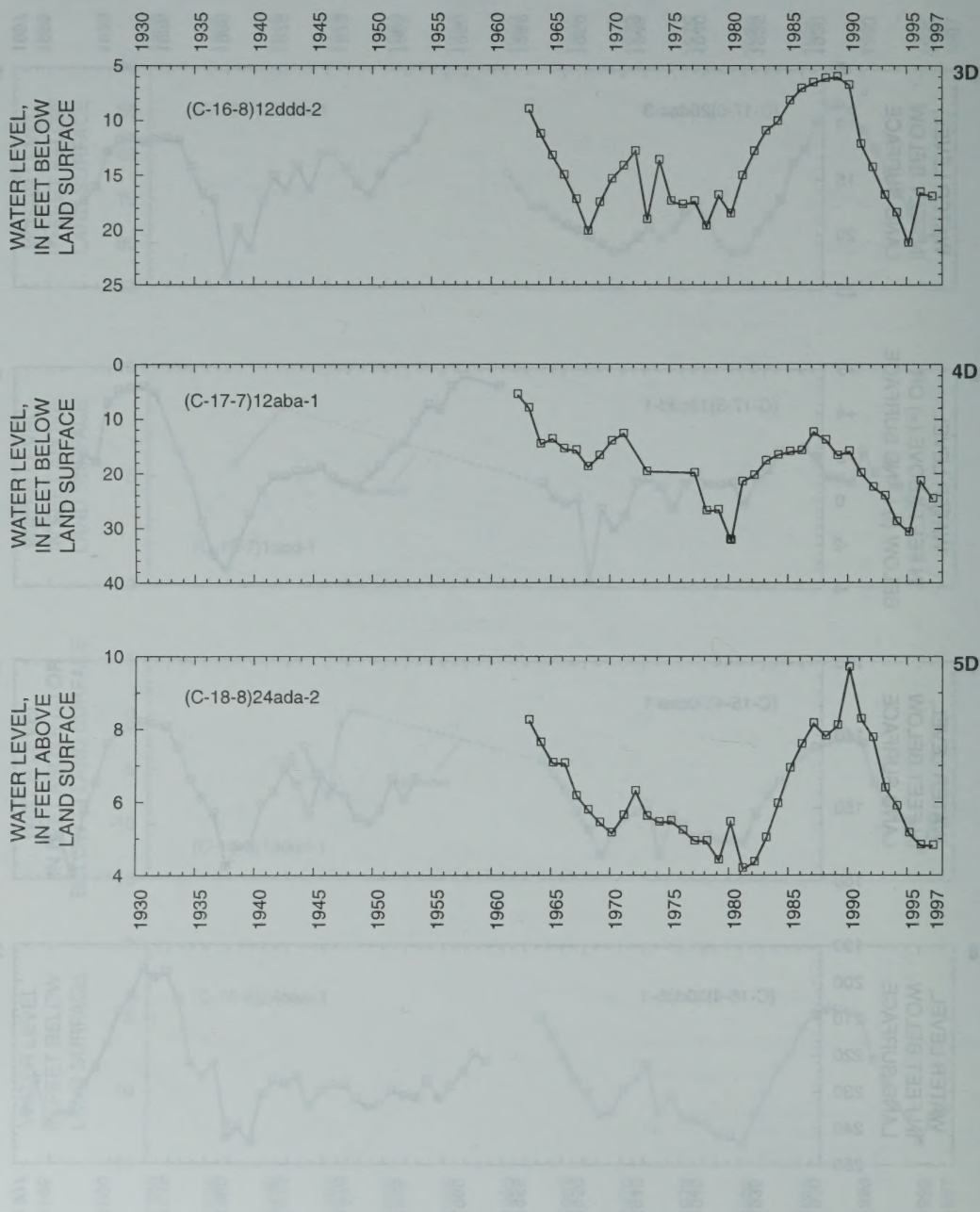
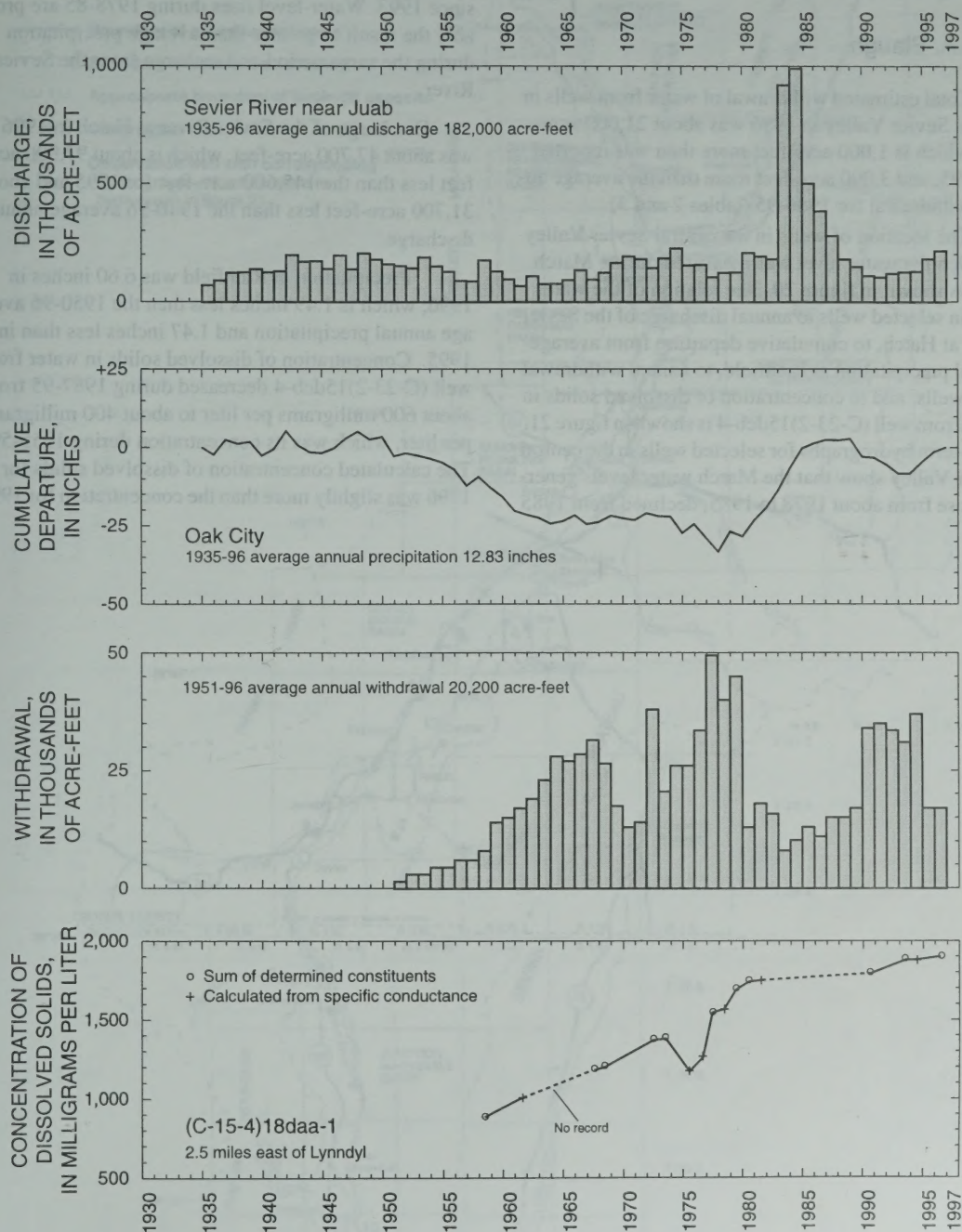


Figure 19. Relation of water level in selected wells in the Sevier Desert to annual discharge of the Sevier River near Juab, to cumulative departure from average annual precipitation at Oak City, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-15-4)18daa-1—Continued.





**Figure 19.** Relation of water level in selected wells in the Sevier Desert to annual discharge of the Sevier River near Juab, to cumulative departure from average annual precipitation at Oak City, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-15-4)18daa-1—Continued.

## CENTRAL SEVIER VALLEY

By B.A. Slauch

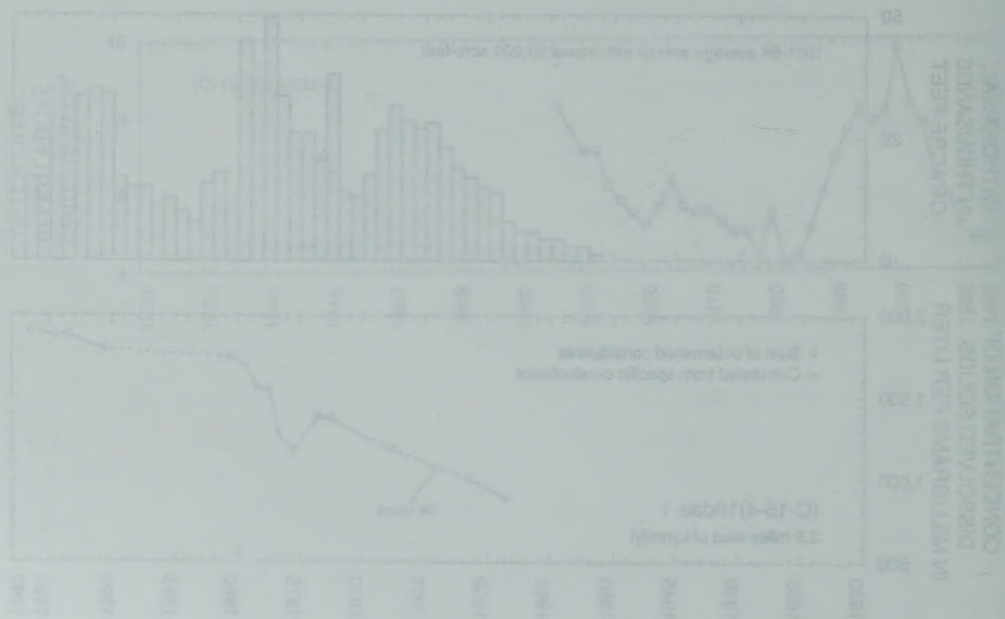
Total estimated withdrawal of water from wells in central Sevier Valley in 1996 was about 21,000 acre-feet, which is 1,000 acre-feet more than was reported for 1995, and 3,000 acre-feet more than the average annual withdrawal for 1986-95 (tables 2 and 3).

The location of wells in the central Sevier Valley in which the water level was measured during March 1997 is shown in figure 20. The relation of the water level in selected wells to annual discharge of the Sevier River at Hatch, to cumulative departure from average annual precipitation at Richfield, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-23-2)15dcb-4 is shown in figure 21. Long-term hydrographs for selected wells in the central Sevier Valley show that the March water levels generally rose from about 1978 to 1985, declined from 1985

to about 1993, and have been stable or risen slightly since 1993. Water-level rises during 1978-85 are probably the result of greater-than-average precipitation during the same period and recharge from the Sevier River.

Discharge of the Sevier River at Hatch in 1996 was about 47,700 acre-feet, which is about 97,900 acre-feet less than the 145,600 acre-feet for 1995 and about 31,700 acre-feet less than the 1940-96 average annual discharge.

Precipitation at Richfield was 6.60 inches in 1996, which is 1.49 inches less than the 1950-96 average annual precipitation and 1.47 inches less than in 1995. Concentration of dissolved solids in water from well (C-23-2)15dcb-4 decreased during 1987-95 from about 600 milligrams per liter to about 400 milligrams per liter, which was its concentration during 1955-59. The calculated concentration of dissolved solids for 1996 was slightly more than the concentration for 1995.





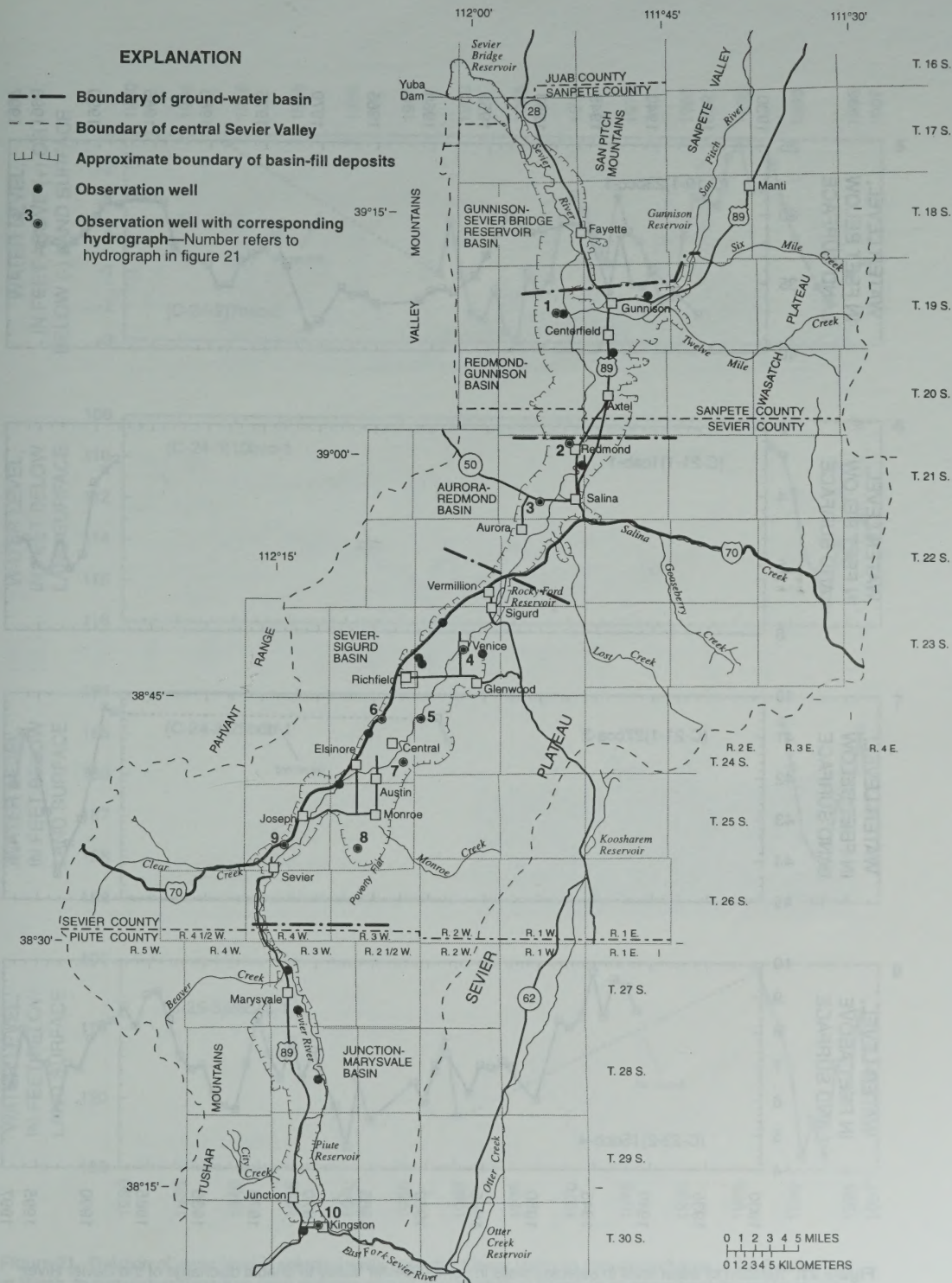
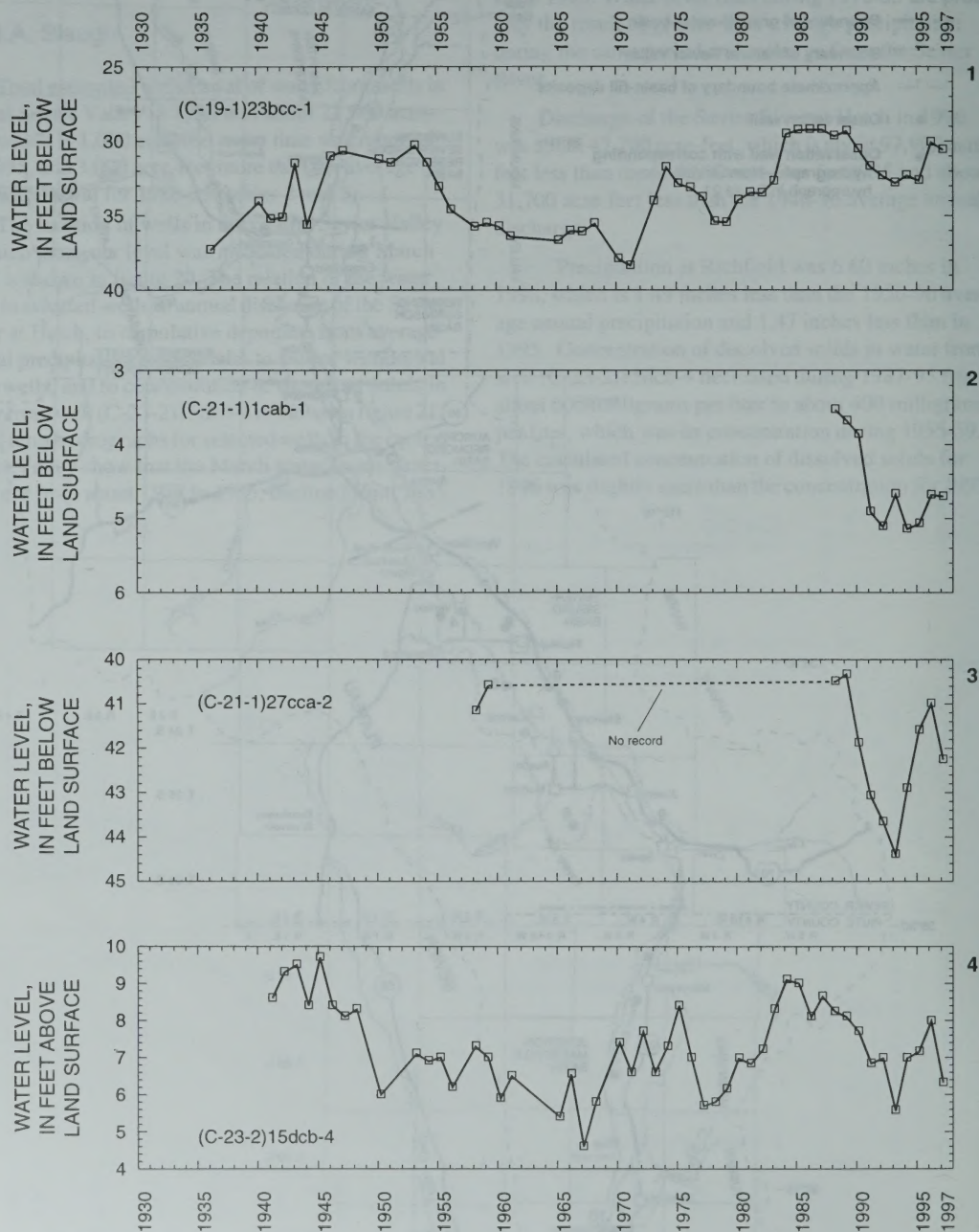
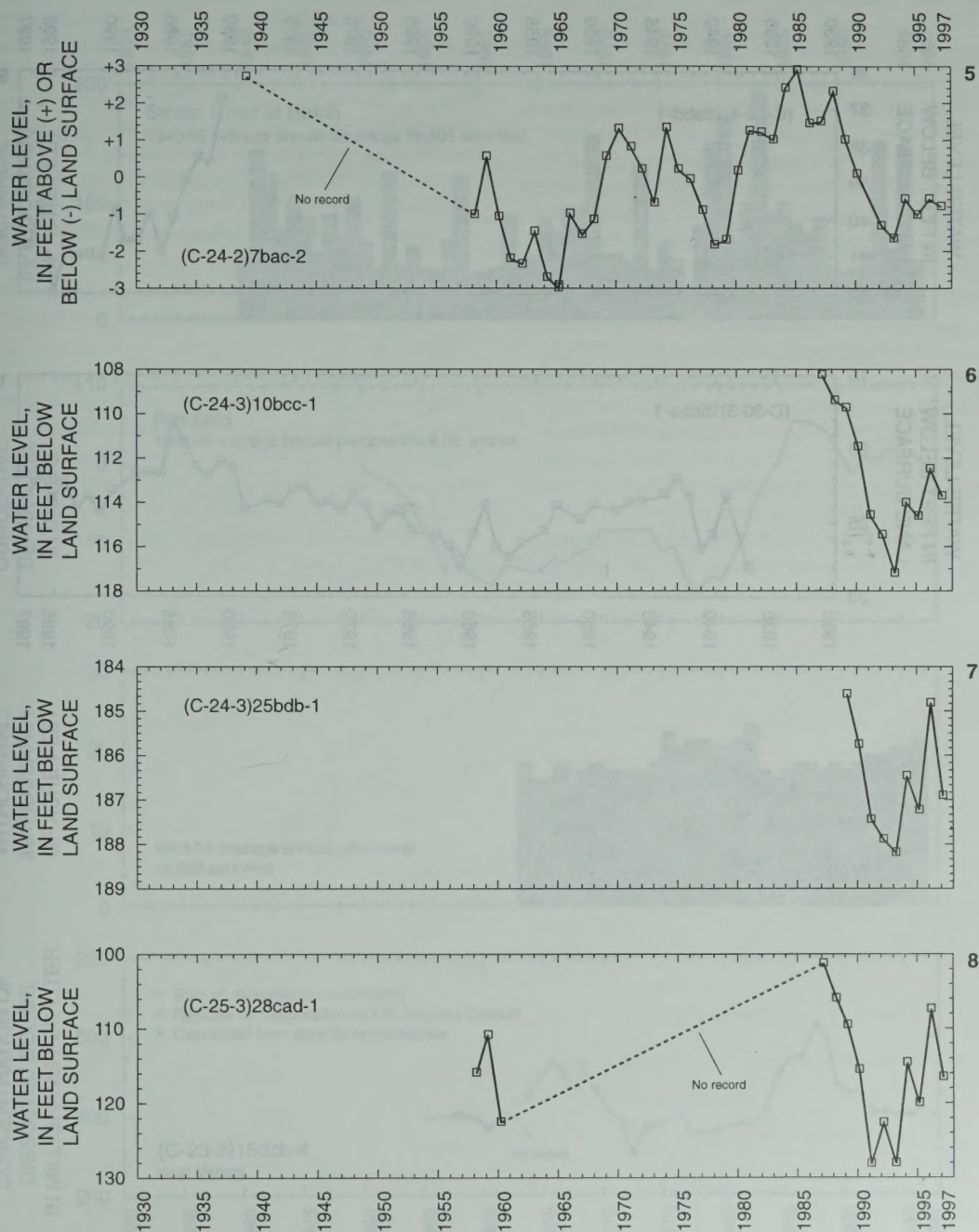


Figure 20. Location of wells in central Sevier Valley in which the water level was measured during March 1997.

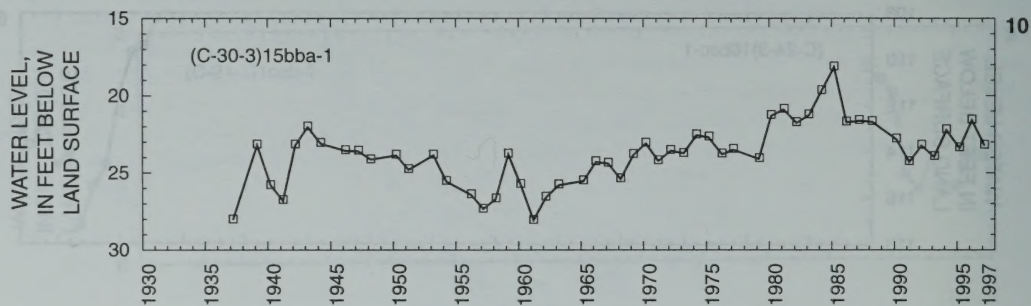
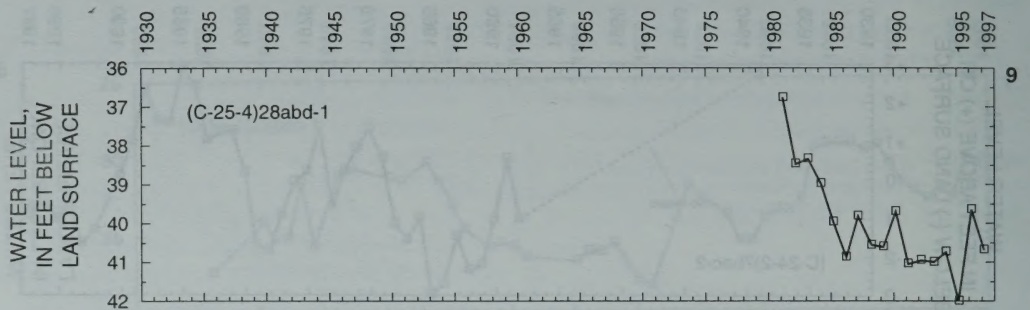


**Figure 21.** Relation of water level in selected wells in central Sevier Valley to annual discharge of the Sevier River at Hatch, to cumulative departure from average annual precipitation at Richfield, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-23-2)15dcb-4.



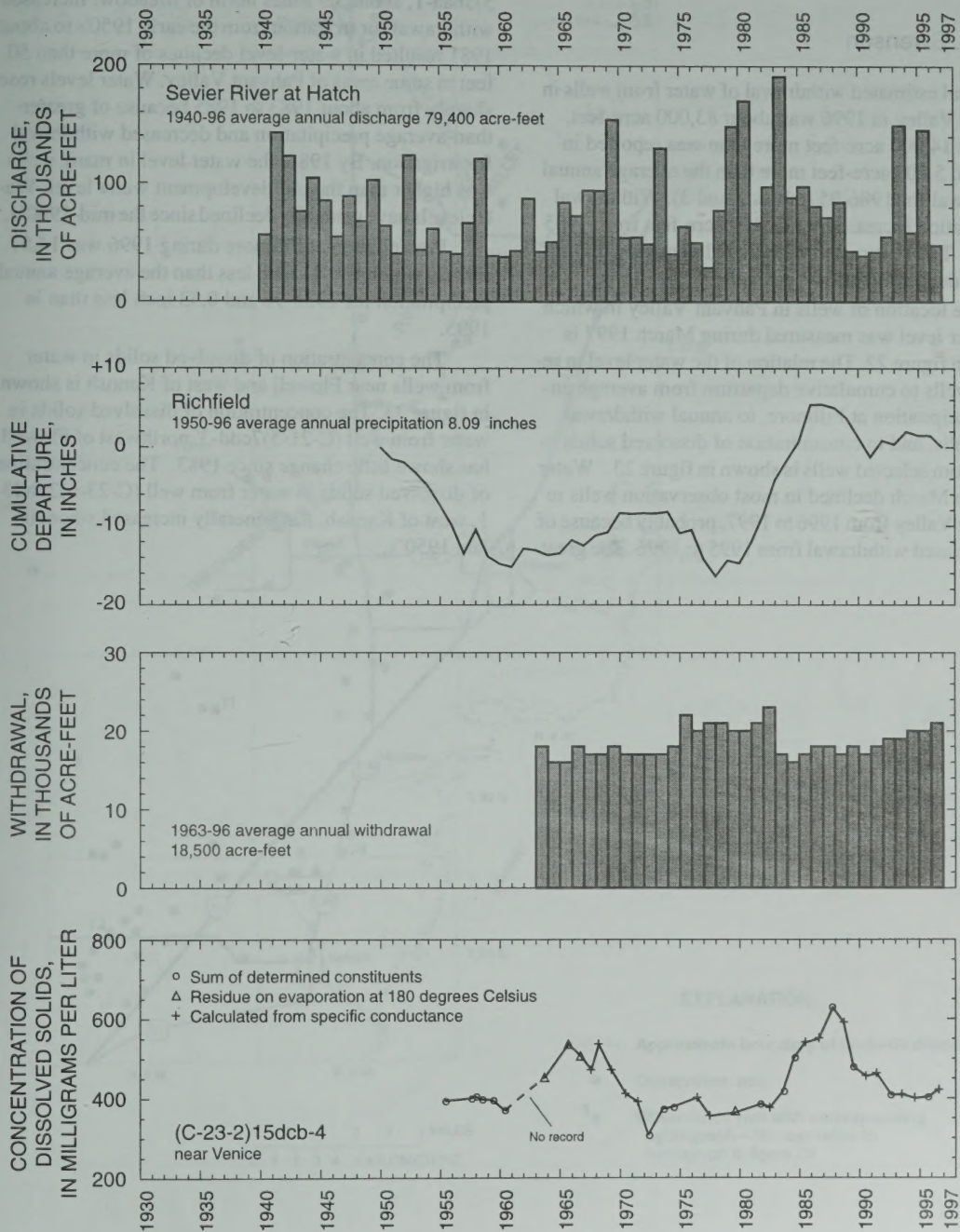


**Figure 21.** Relation of water level in selected wells in central Sevier Valley to annual discharge of the Sevier River at Hatch, to cumulative departure from average annual precipitation at Richfield, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-23-2)15dcb-4—Continued.



**Figure 21.** Relation of water level in selected wells in central Sevier Valley to annual discharge of the Sevier River at Hatch, to cumulative departure from average annual precipitation at Richfield, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-23-2)15dcb-4—Continued.





**Figure 21.** Relation of water level in selected wells in central Sevier Valley to annual discharge of the Sevier River at Hatch, to cumulative departure from average annual precipitation at Richfield, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-23-2)15dcb-4—Continued.

## PAHVANT VALLEY

By R.L. Swenson

Total estimated withdrawal of water from wells in Pahvant Valley in 1996 was about 83,000 acre-feet, which is 14,000 acre-feet more than was reported in 1995 and 5,000 acre-feet more than the average annual withdrawal for 1986-95 (tables 2 and 3). Withdrawal for irrigation increased by 13,400 acre-feet from 1995 to 1996. Total estimated withdrawal generally has increased during the last 10 years.

The location of wells in Pahvant Valley in which the water level was measured during March 1997 is shown in figure 22. The relation of the water level in selected wells to cumulative departure from average annual precipitation at Fillmore, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells is shown in figure 23. Water levels in March declined in most observation wells in Pahvant Valley from 1996 to 1997, probably because of the increased withdrawal from 1995 to 1996. The great-

est decline, about 7.2 feet, occurred in well (C-22-5)3baa-1, about 3.5 miles north of Meadow. Increased withdrawal for irrigation from the early 1950's to about 1981 resulted in water-level declines of more than 50 feet in some areas of Pahvant Valley. Water levels rose sharply from about 1983 to 1985 because of greater-than-average precipitation and decreased withdrawal for irrigation. By 1986, the water level in many wells was higher than the pre-development water level. Water levels have generally declined since the mid-1980's.

Precipitation at Fillmore during 1996 was 14.57 inches, which is 0.41 inch less than the average annual precipitation for 1931-96 and 0.53 inch less than in 1995.

The concentration of dissolved solids in water from wells near Flowell and west of Kanosh is shown in figure 23. The concentration of dissolved solids in water from well (C-21-5)7cdd-3, northwest of Flowell, has shown little change since 1983. The concentration of dissolved solids in water from well (C-23-6)21bdd-1, west of Kanosh, has generally increased since the late 1950's.





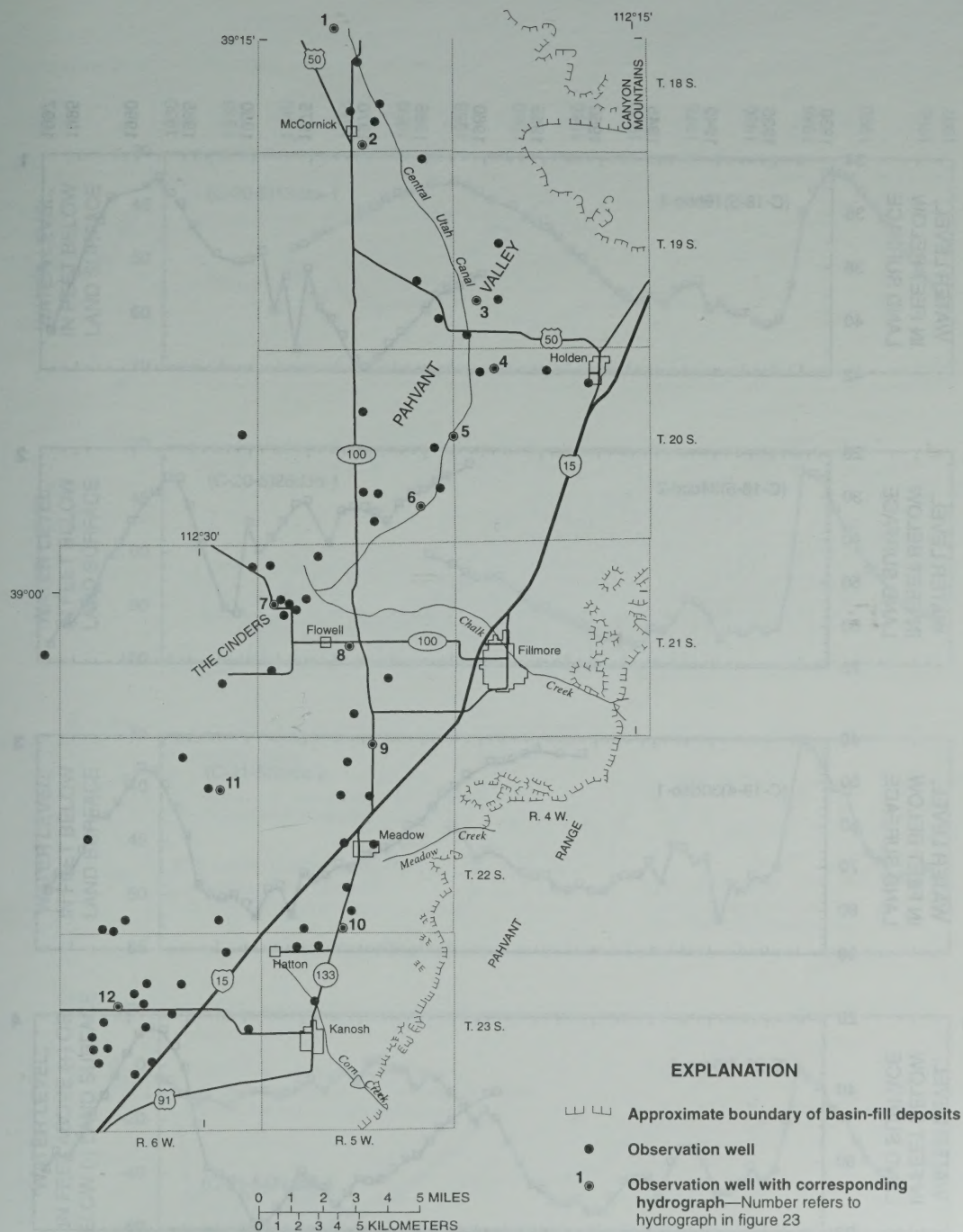


Figure 22. Location of wells in Pahvant Valley in which the water level was measured during March 1997.

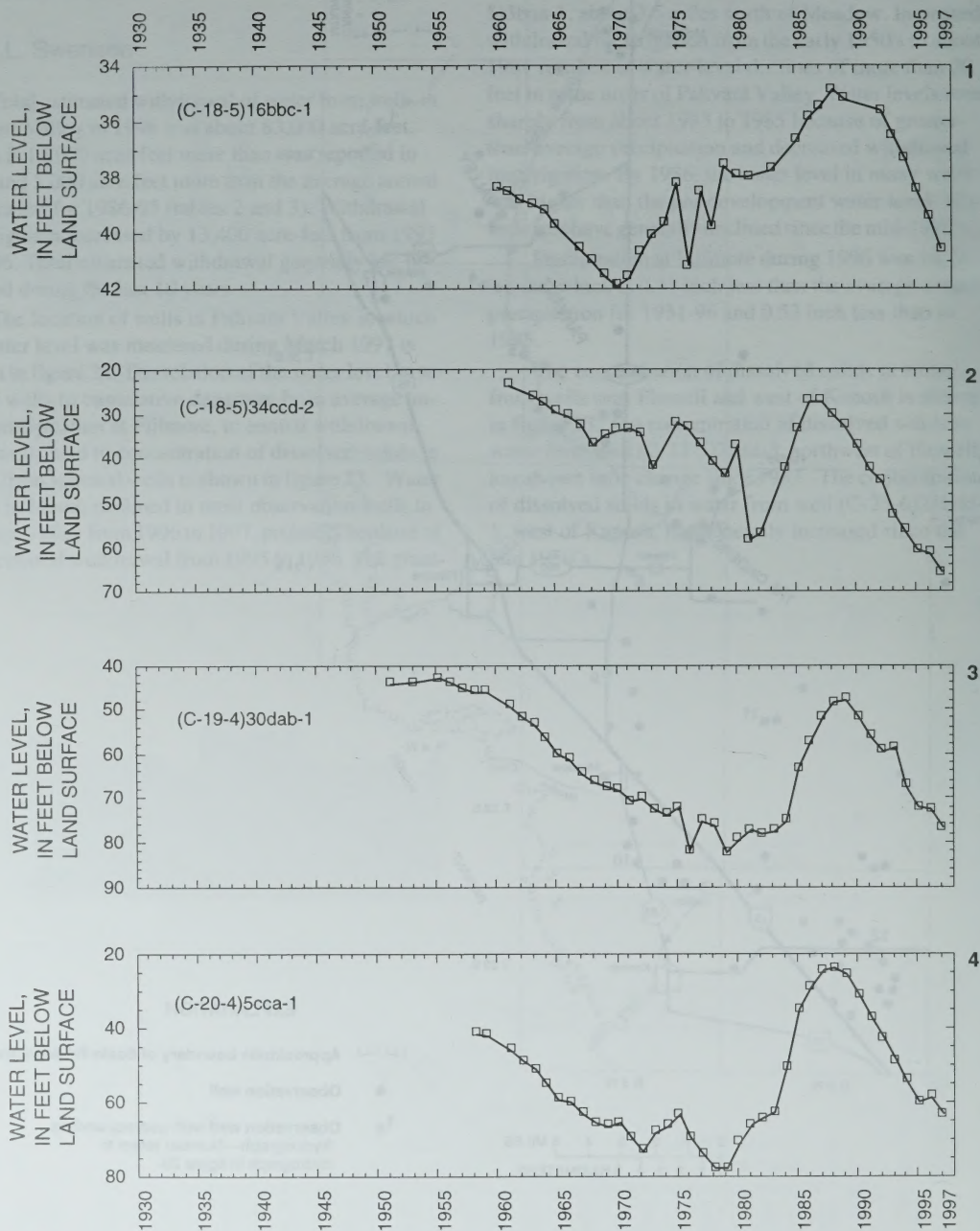
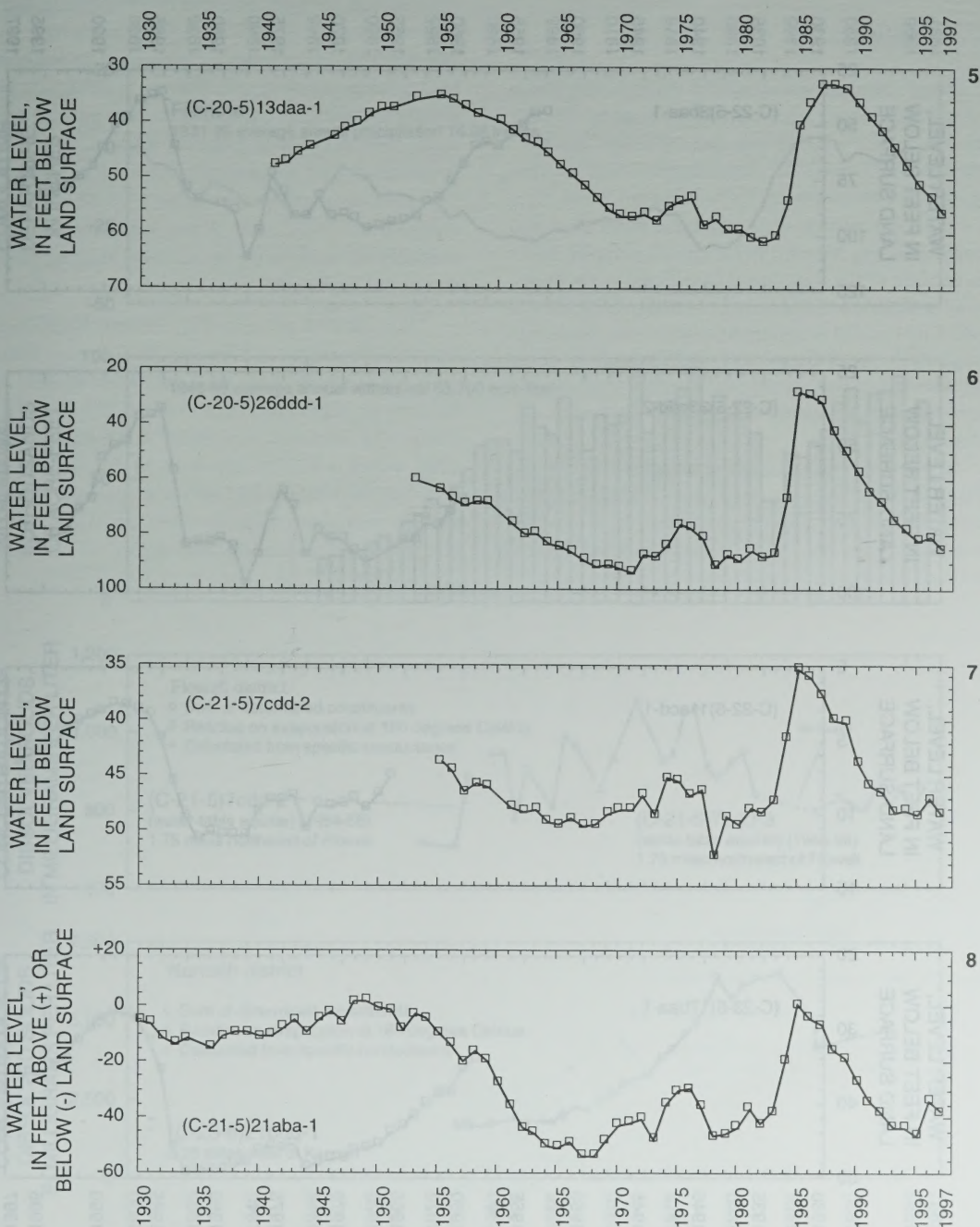
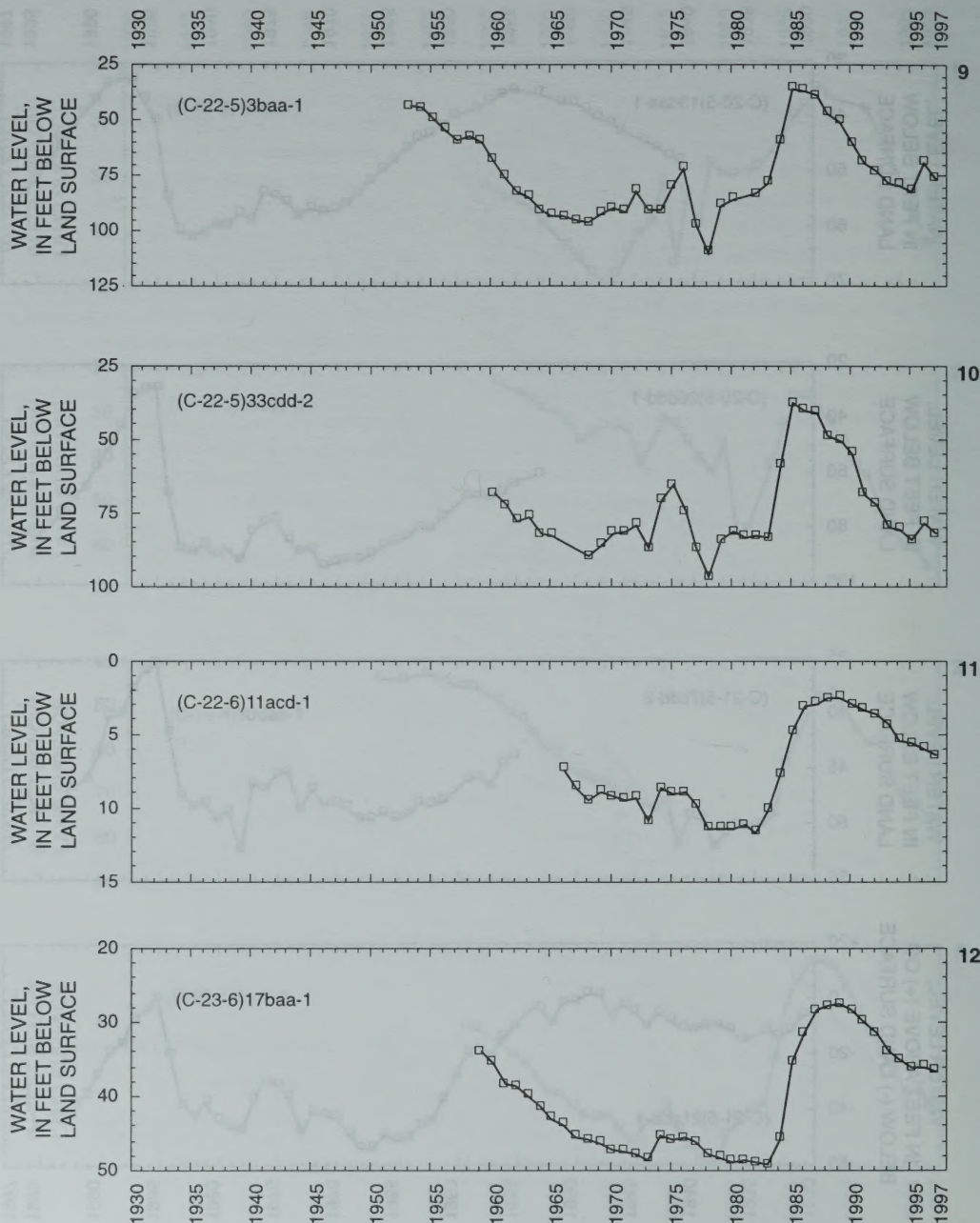


Figure 23. Relation of water level in selected wells in Pahvant Valley to cumulative departure from average annual precipitation at Fillmore, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells.



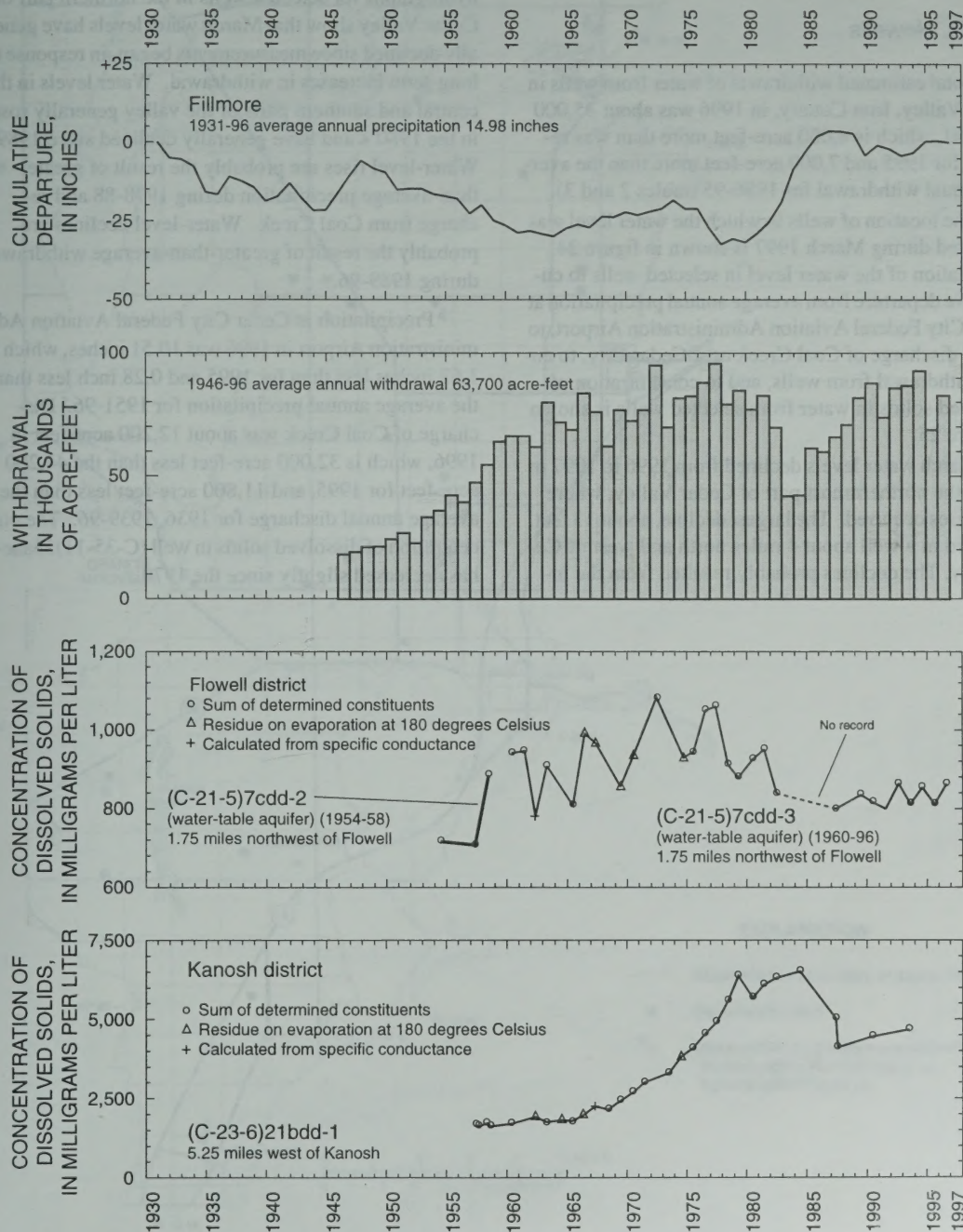


**Figure 23.** Relation of water level in selected wells in Pahvant Valley to cumulative departure from average annual precipitation at Fillmore, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells—Continued.



**Figure 23.** Relation of water level in selected wells in Pahvant Valley to cumulative departure from average annual precipitation at Fillmore, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells—Continued.





**Figure 23.** Relation of water level in selected wells in Pahvant Valley to cumulative departure from average annual precipitation at Fillmore, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells—Continued.

## CEDAR VALLEY, IRON COUNTY

By J.H. Howells

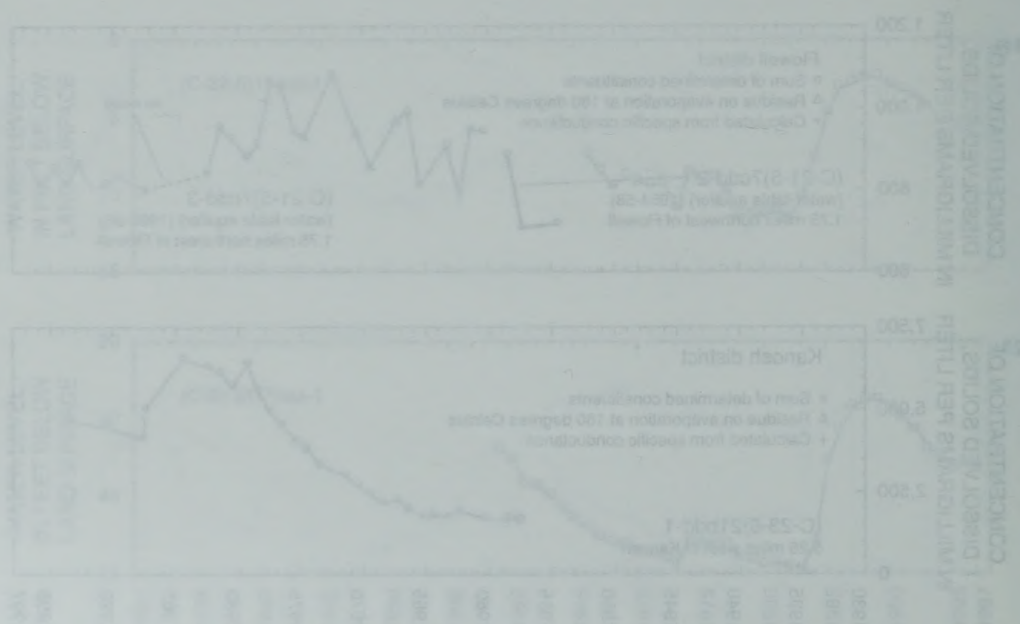
Total estimated withdrawal of water from wells in Cedar Valley, Iron County, in 1996 was about 35,000 acre-feet, which is 4,000 acre-feet more than was reported for 1995 and 7,000 acre-feet more than the average annual withdrawal for 1986-95 (tables 2 and 3).

The location of wells in which the water level was measured during March 1997 is shown in figure 24. The relation of the water level in selected wells to cumulative departure from average annual precipitation at Cedar City Federal Aviation Administration Airport, to annual discharge of Coal Creek near Cedar City, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells is shown in figure 25.

March water levels declined from 1996 to 1997 in all but the northernmost part of Cedar Valley, where small rises occurred. The largest decline, about 13 feet, occurred in a well about 4 miles north and west of Cedar City. The declines probably resulted from the in-

creased withdrawal from 1995 to 1996. Long-term hydrographs for selected wells in the northern part of Cedar Valley show that March water levels have generally declined since measurements began, in response to long-term increases in withdrawal. Water levels in the central and southern parts of the valley generally rose in the 1980's and have generally declined since 1989. Water-level rises are probably the result of greater-than-average precipitation during 1978-88 and recharge from Coal Creek. Water-level declines are probably the result of greater-than-average withdrawal during 1989-96.

Precipitation at Cedar City Federal Aviation Administration Airport in 1996 was 10.51 inches, which is 1.63 inches less than for 1995 and 0.28 inch less than the average annual precipitation for 1951-96. Discharge of Coal Creek was about 12,200 acre-feet in 1996, which is 32,000 acre-feet less than the 44,200 acre-feet for 1995, and 11,800 acre-feet less than the average annual discharge for 1936, 1939-96. The concentration of dissolved solids in well (C-35-11)33aac-1 has decreased slightly since the 1970's.





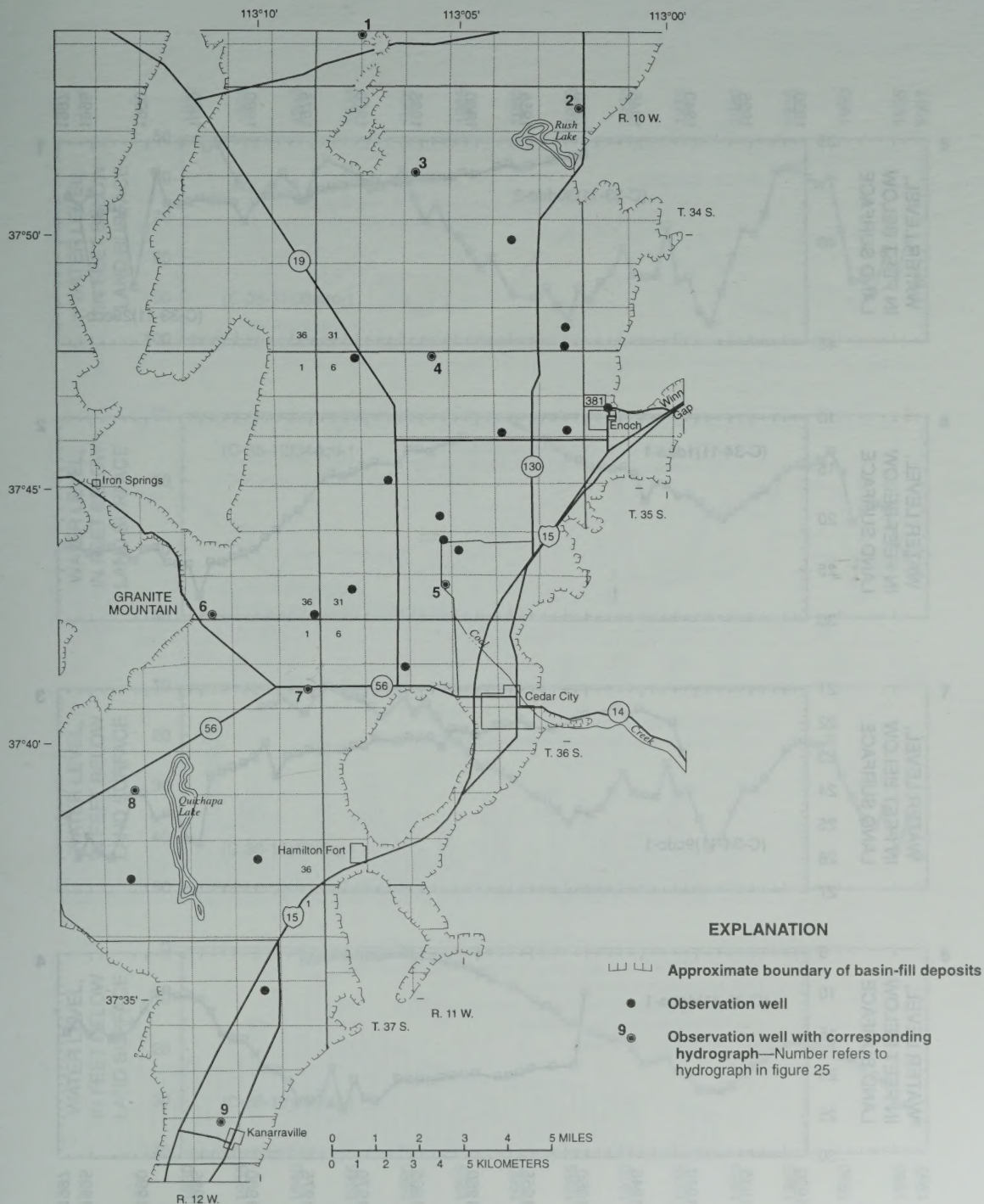
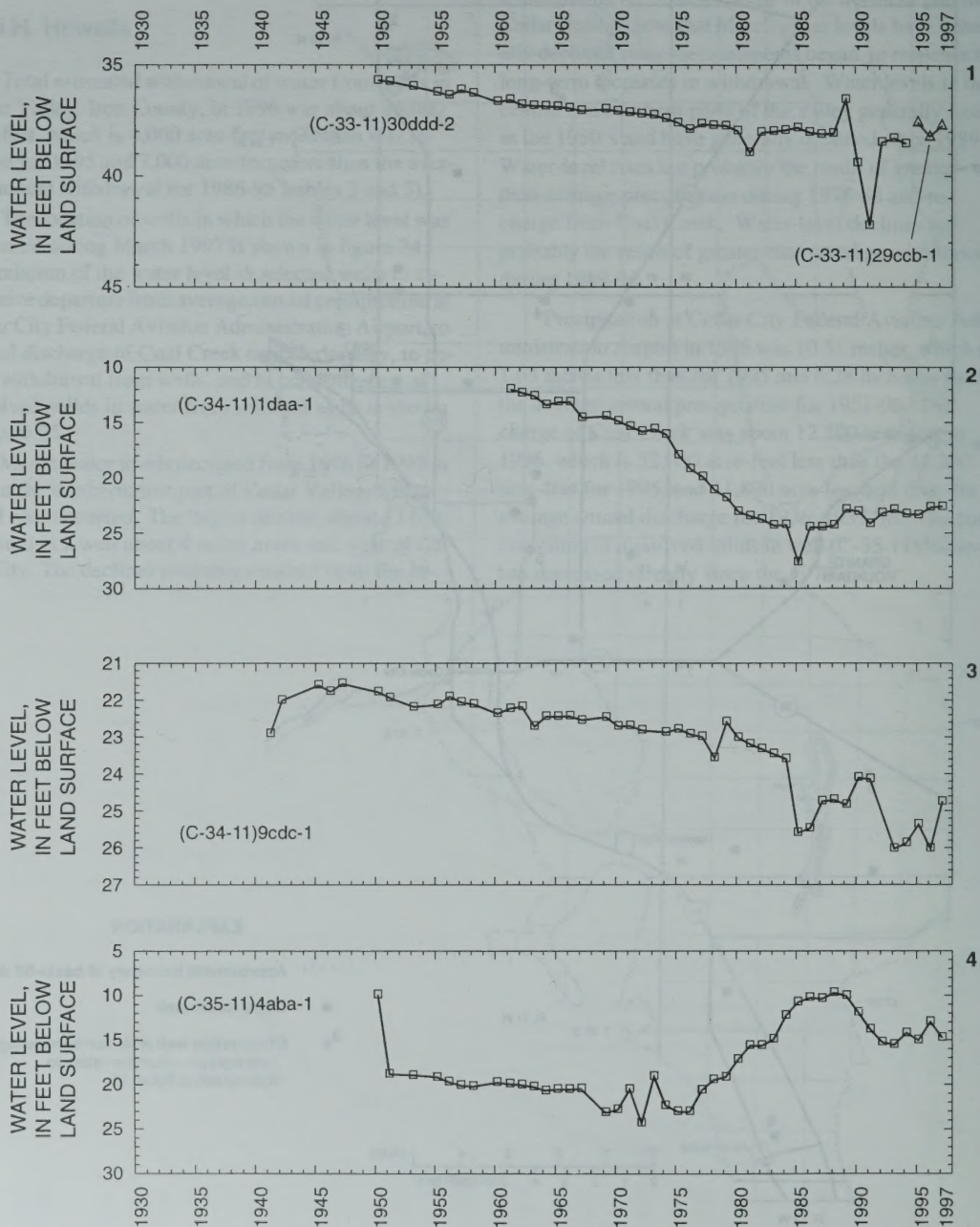
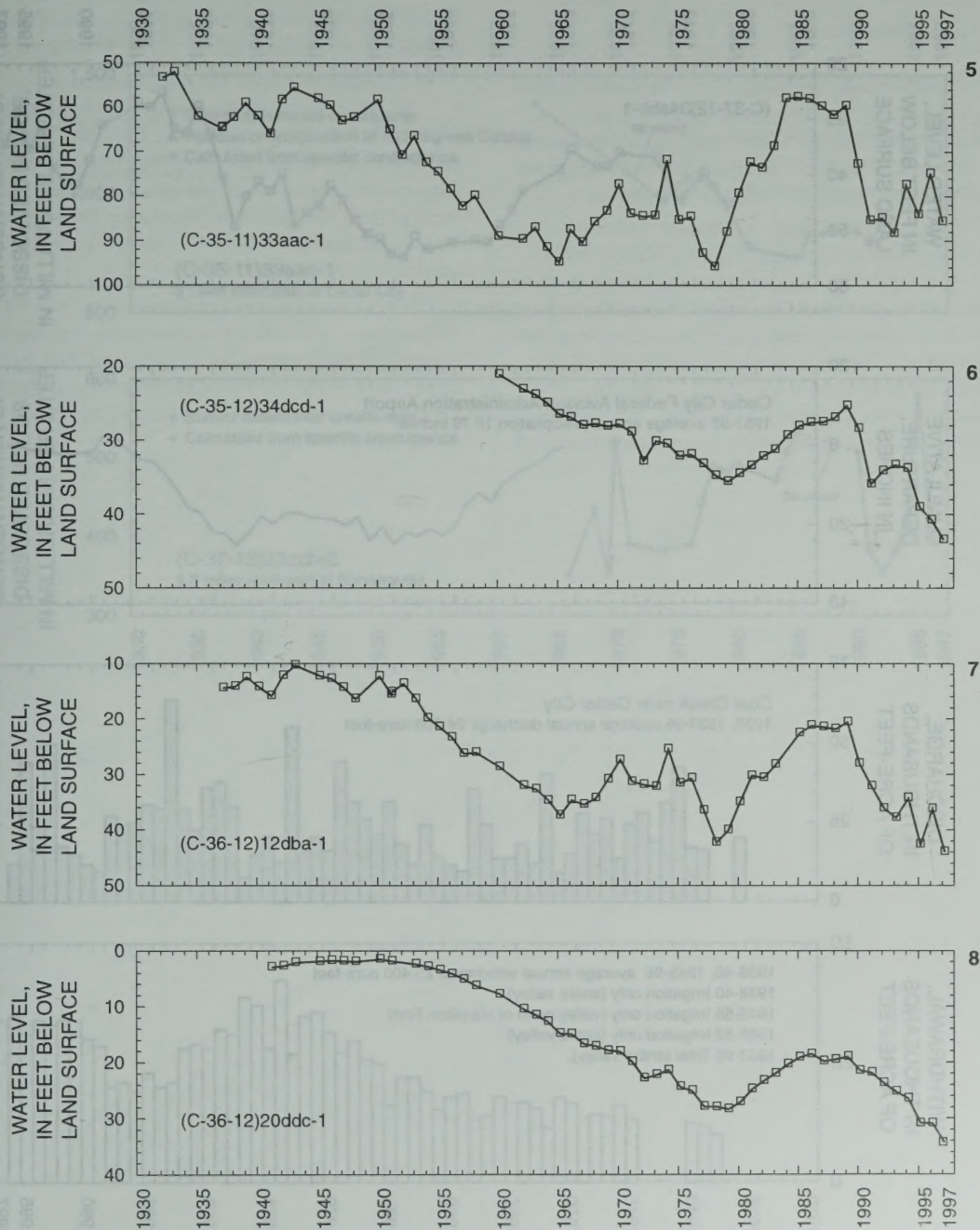


Figure 24. Location of wells in Cedar Valley, Iron County, in which the water level was measured during March 1997.

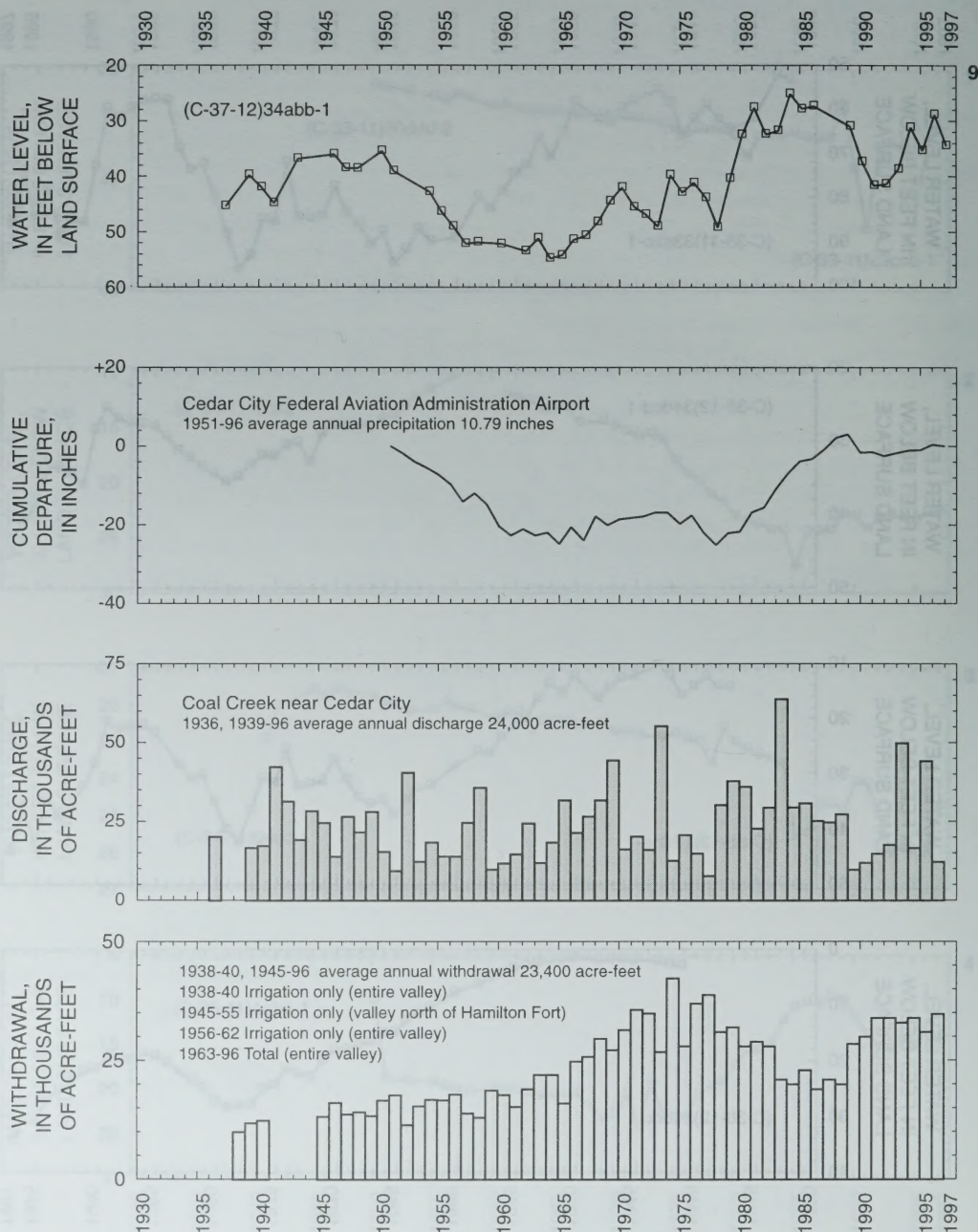


**Figure 25.** Relation of water level in selected wells in Cedar Valley, Iron County, to cumulative departure from average annual precipitation at Cedar City Federal Aviation Administration Airport, to annual discharge of Coal Creek near Cedar City, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells.





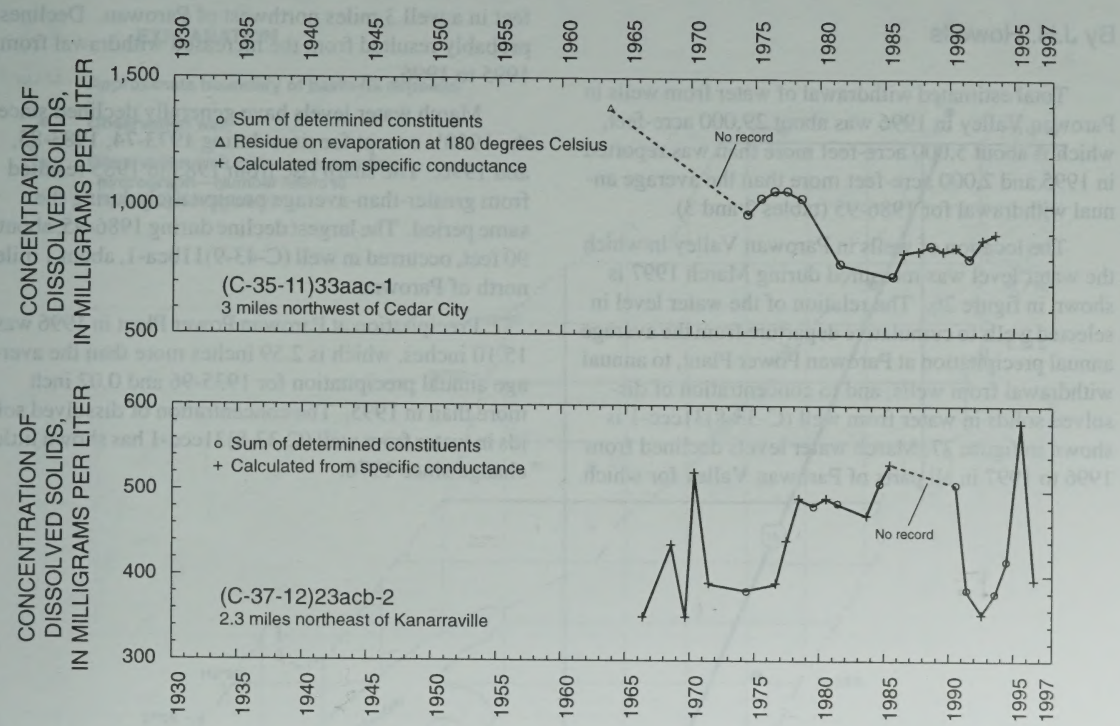
**Figure 25.** Relation of water level in selected wells in Cedar Valley, Iron County, to cumulative departure from average annual precipitation at Cedar City Federal Aviation Administration Airport, to annual discharge of Coal Creek near Cedar City, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells—Continued.



**Figure 25.** Relation of water level in selected wells in Cedar Valley, Iron County, to cumulative departure from average annual precipitation at Cedar City Federal Aviation Administration Airport, to annual discharge of Coal Creek near Cedar City, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells—Continued.



data are available. Declines ranged from about 1 foot as a well 1 mile southwest of Farmington, to about 10 feet in a well 1 mile southwest of Farmington. Declines in 1980 were about 1 foot in a well 1 mile southwest of Farmington. Declines in 1980 were about 1 foot in a well 1 mile southwest of Farmington. Declines in 1980 were about 1 foot in a well 1 mile southwest of Farmington.



**Figure 25.** Relation of water level in selected wells in Cedar Valley, Iron County, to cumulative departure from average annual precipitation at Cedar City Federal Aviation Administration Airport, to annual discharge of Coal Creek near Cedar City, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells—Continued.

# PAROWAN VALLEY

By J.H. Howells

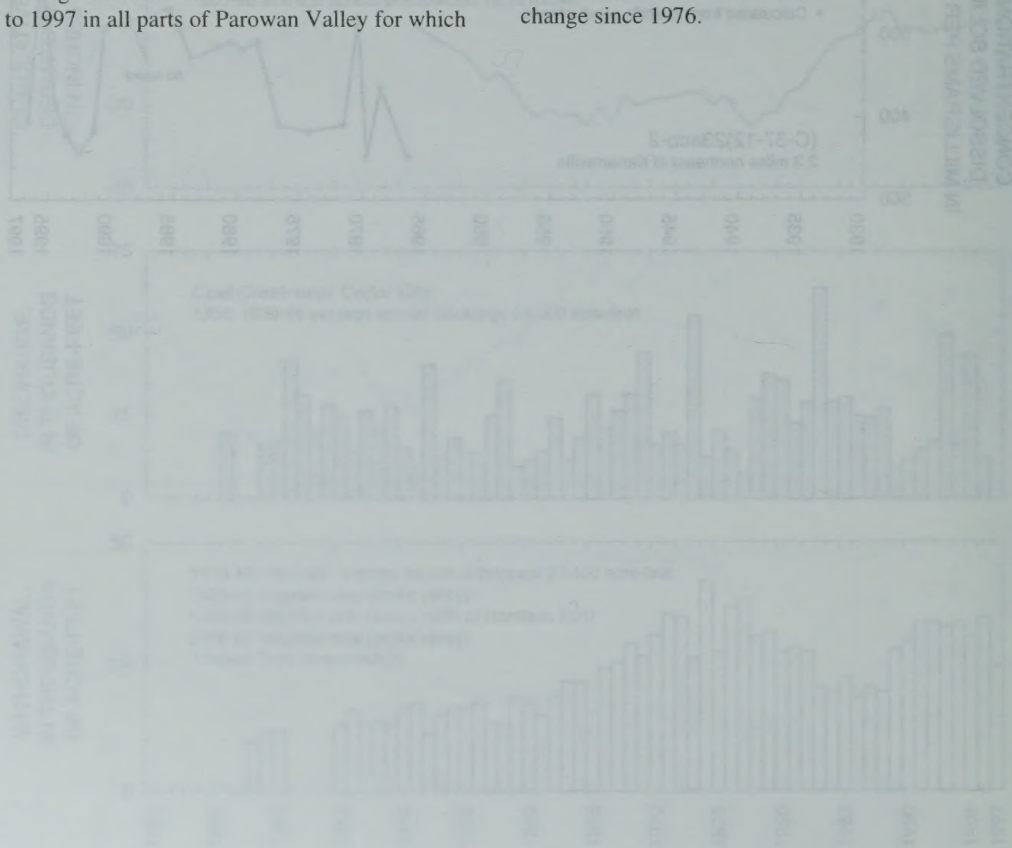
Total estimated withdrawal of water from wells in Parowan Valley in 1996 was about 29,000 acre-feet, which is about 5,000 acre-feet more than was reported in 1995 and 2,000 acre-feet more than the average annual withdrawal for 1986-95 (tables 2 and 3).

The location of wells in Parowan Valley in which the water level was measured during March 1997 is shown in figure 26. The relation of the water level in selected wells to cumulative departure from the average annual precipitation at Parowan Power Plant, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-33-8)31ccc-1 is shown in figure 27. March water levels declined from 1996 to 1997 in all parts of Parowan Valley for which

data are available. Declines ranged from about 1 foot in a well 1 mile southwest of Paragonah, to about 10 feet in a well 3 miles northwest of Parowan. Declines probably resulted from the increased withdrawal from 1995 to 1996.




March water levels have generally declined since the 1950's except for rises during 1973-74, 1983-85, and 1996. The sharp rise from 1983 to 1985 resulted from greater-than-average precipitation during the same period. The largest decline during 1986-95, about 90 feet, occurred in well (C-43-9)11bca-1, about 1 mile north of Parowan.

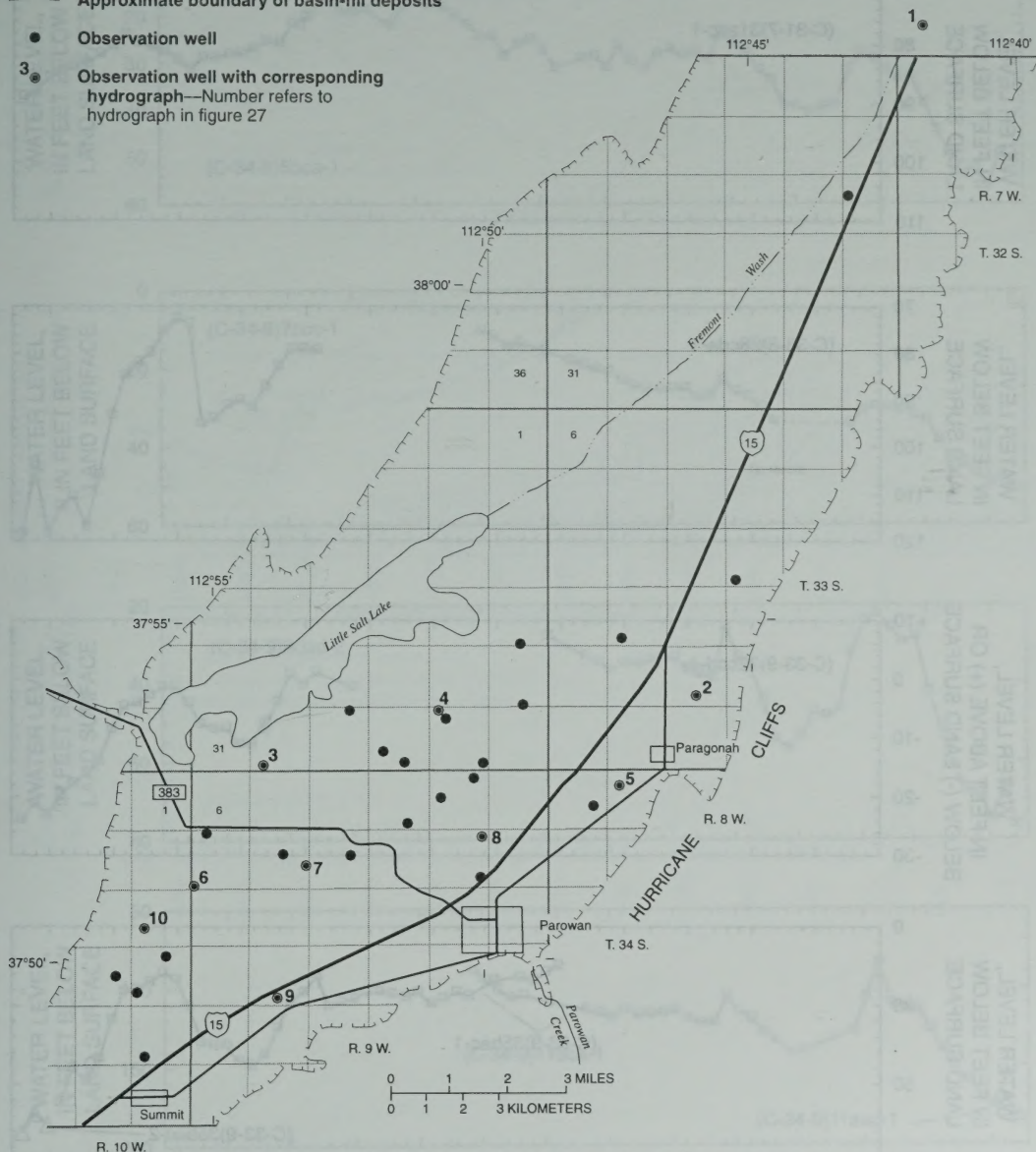
Precipitation at Parowan Power Plant in 1996 was 15.10 inches, which is 2.59 inches more than the average annual precipitation for 1935-96 and 0.02 inch more than in 1995. The concentration of dissolved solids in water from well (C-33-8)31ccc-1 has shown little change since 1976.



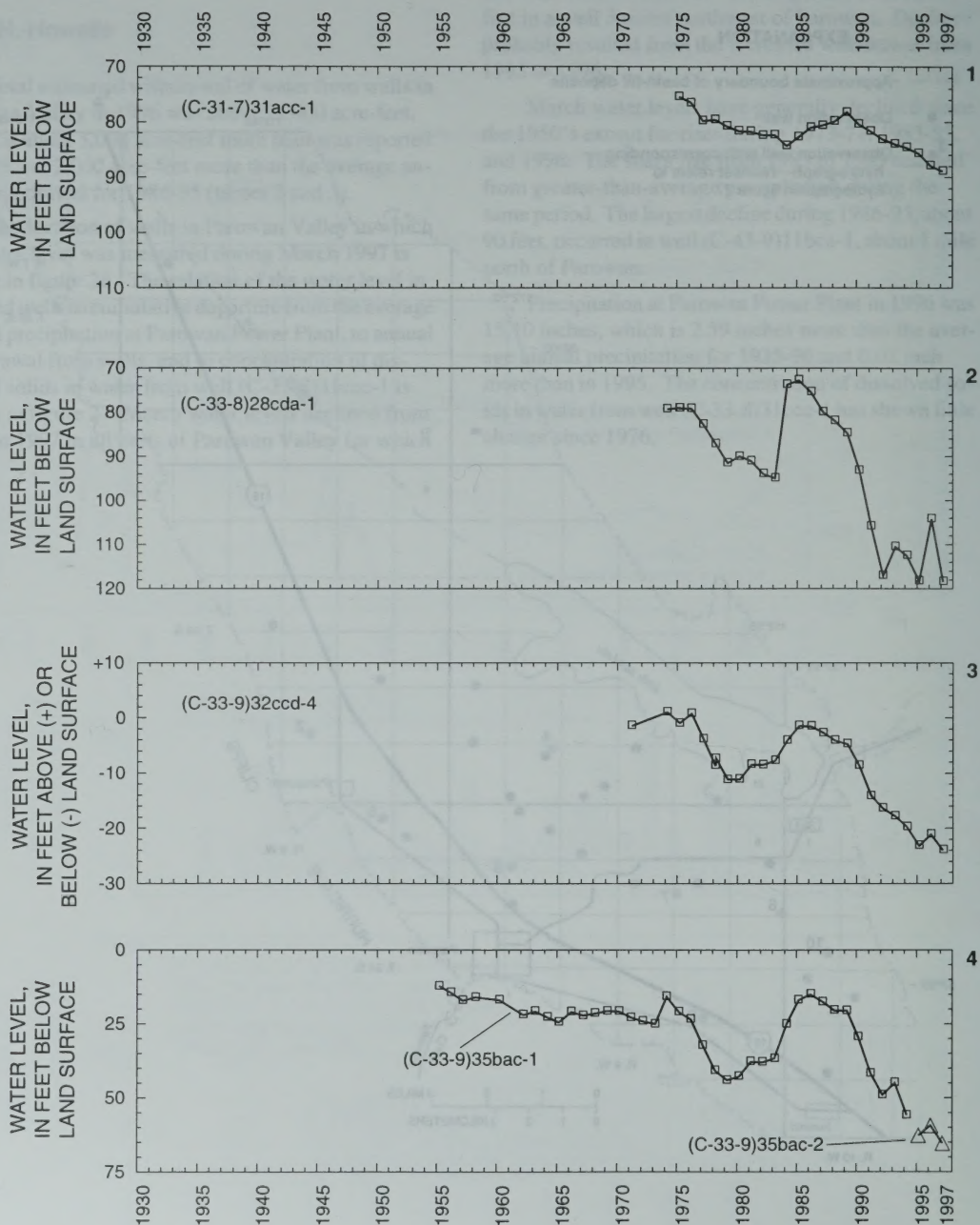


# EXPLANATION

-  Approximate boundary of basin-fill deposits
-  Observation well
-  Observation well with corresponding hydrograph—Number refers to hydrograph in figure 27

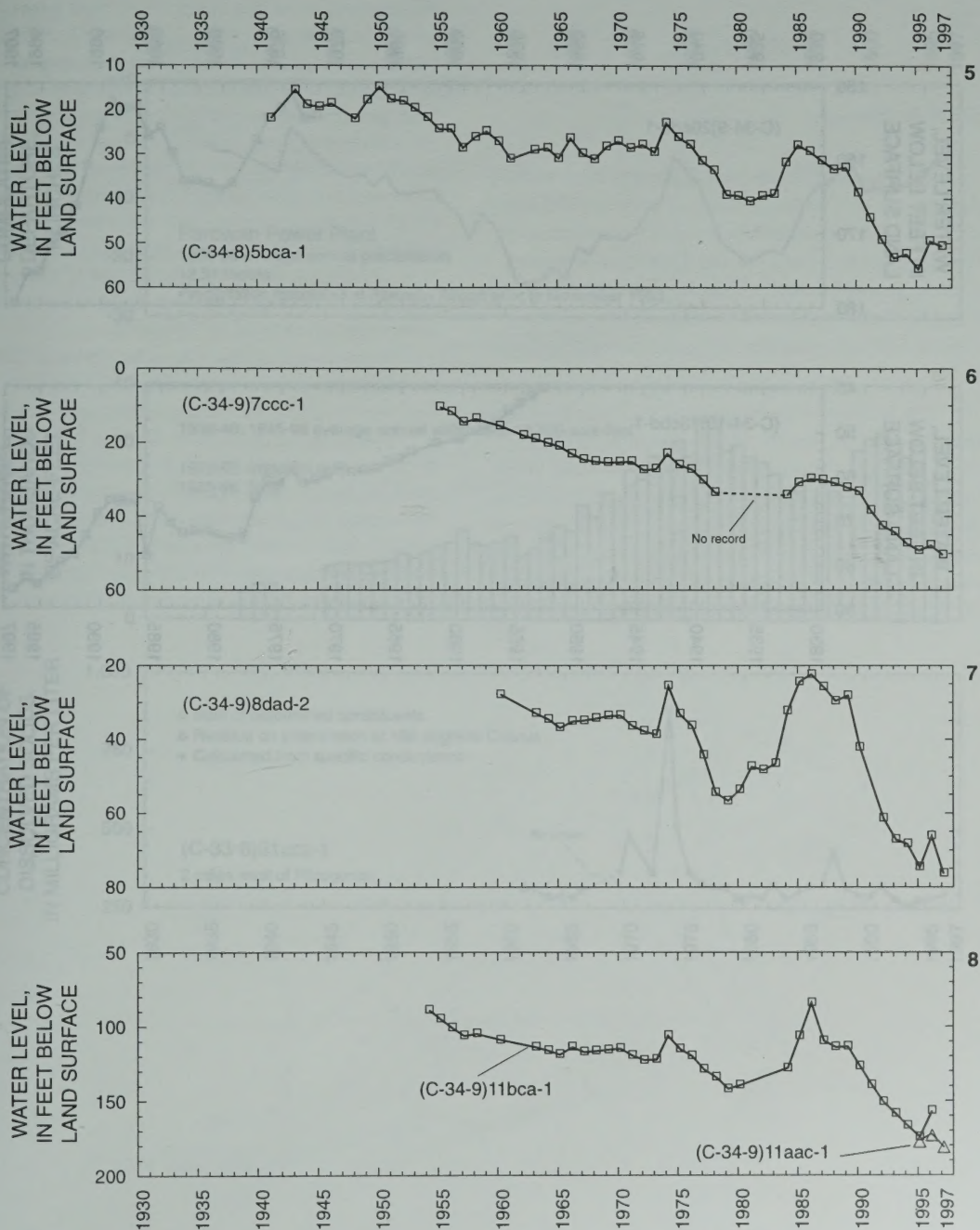


**Figure 26.** Location of wells in Parowan Valley in which the water level was measured during March 1997.

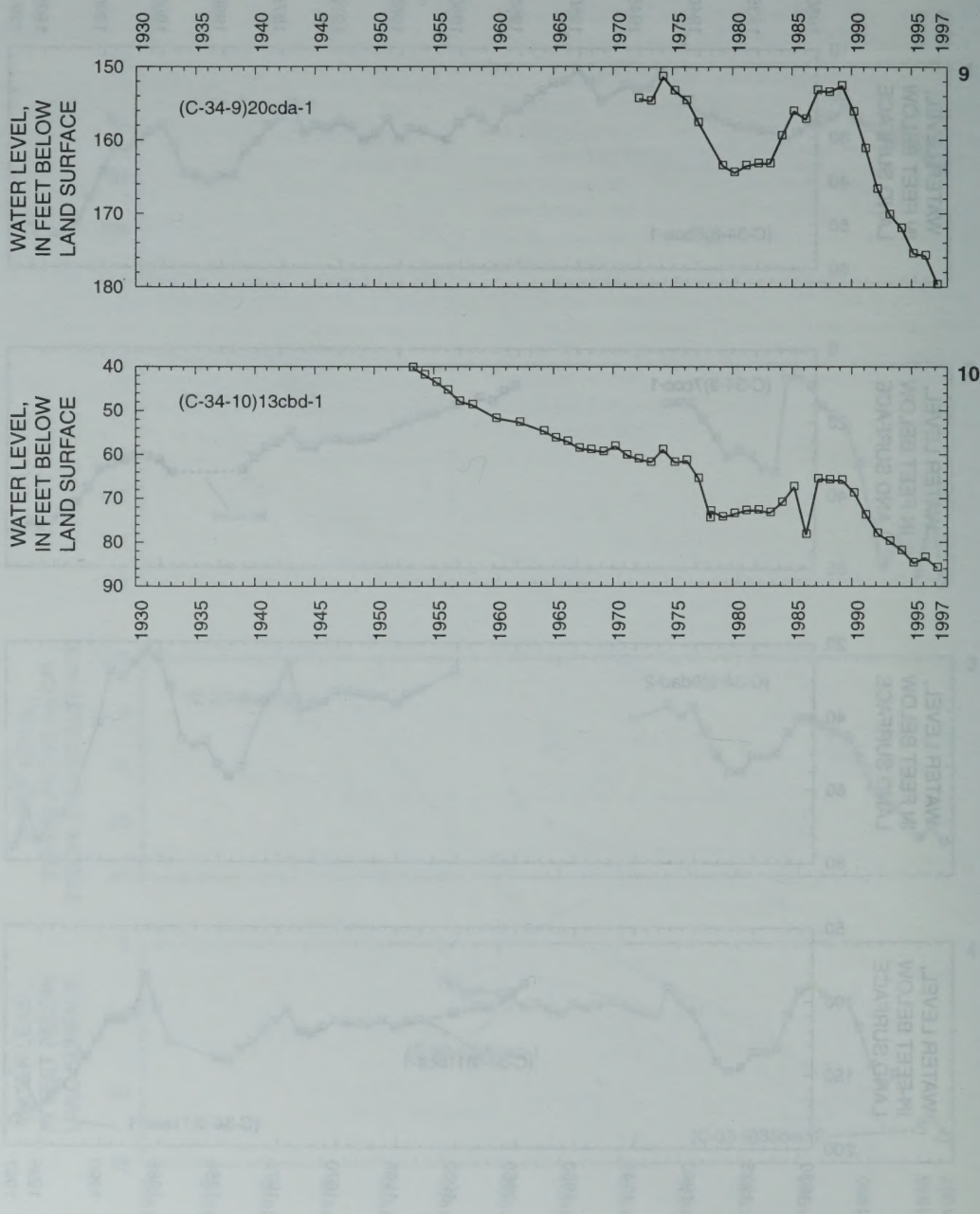


**Figure 27.** Relation of water level in selected wells in Parowan Valley to cumulative departure from average annual precipitation at Parowan Power Plant, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-33-8)31ccc-1.



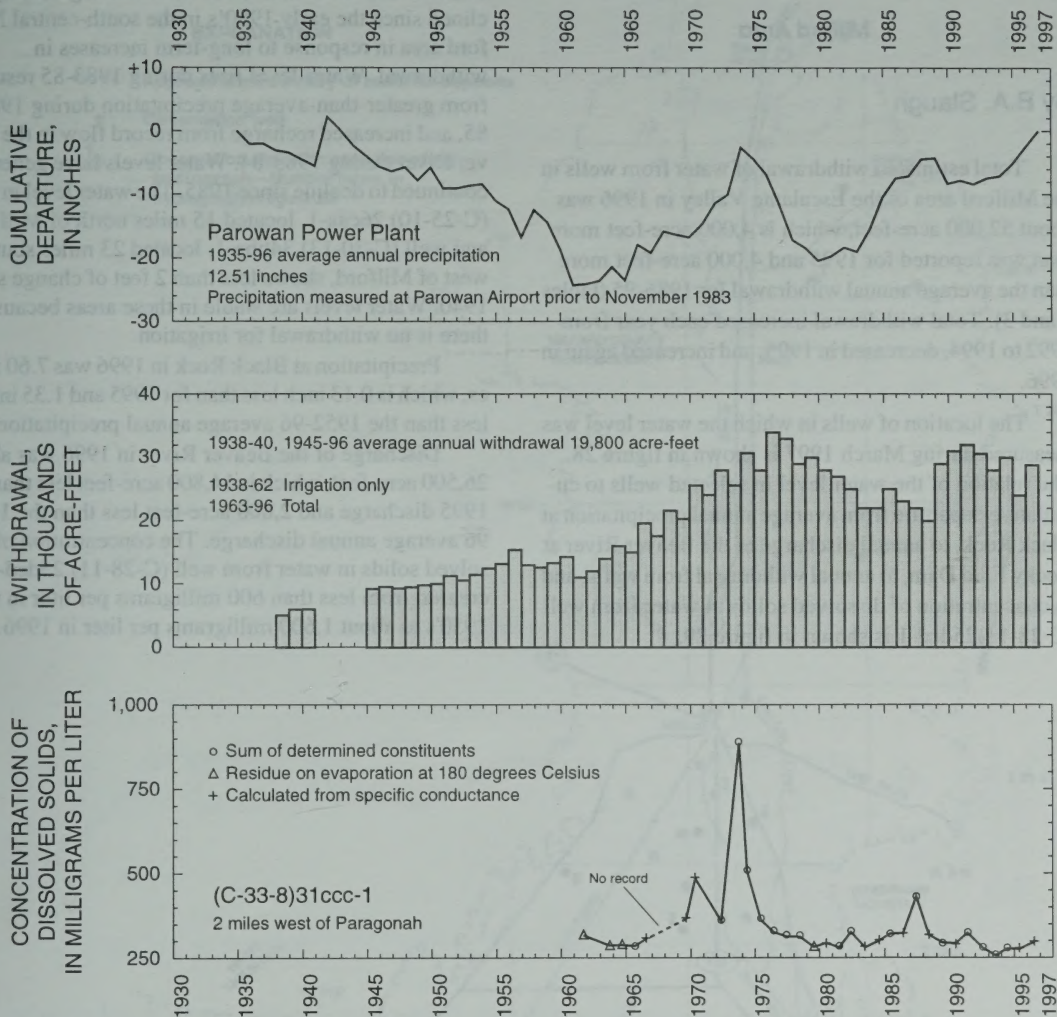


**Figure 27.** Relation of water level in selected wells in Parowan Valley to cumulative departure from average annual precipitation at Parowan Power Plant, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-34-8)31ccc-1—Continued.



**Figure 27.** Relation of water level in selected wells in Parowan Valley to cumulative departure from average annual precipitation at Parowan Power Plant, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-33-8)31ccc-1—Continued.





**Figure 27.** Relation of water level in selected wells in Parowan Valley to cumulative departure from average annual precipitation at Parowan Power Plant, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-33-8)31ccc-1—Continued.

## ESCALANTE VALLEY

### Milford Area

By B.A. Slauch

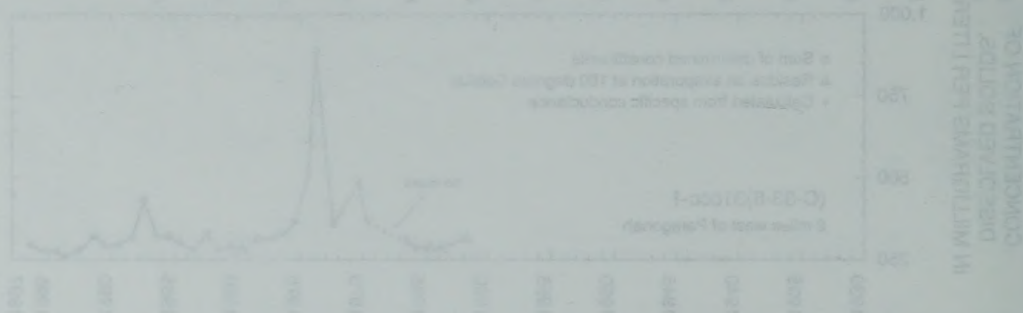
Total estimated withdrawal of water from wells in the Milford area of the Escalante Valley in 1996 was about 52,000 acre-feet, which is 4,000 acre-feet more than was reported for 1995 and 4,000 acre-feet more than the average annual withdrawal for 1986-95 (tables 2 and 3). Total withdrawal increased each year from 1992 to 1994, decreased in 1995, and increased again in 1996.

The location of wells in which the water level was measured during March 1997 is shown in figure 28. The relation of the water level in selected wells to cumulative departure from average annual precipitation at Black Rock, to annual discharge of the Beaver River at Rocky Ford Dam, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-28-11)25dcd-1 is shown in figure 29.

Long-term hydrographs for selected wells in the Milford area show that water levels have generally declined since the early 1950's in the south-central Milford area in response to long-term increases in withdrawal. Water-level rises during 1983-85 resulted from greater-than-average precipitation during 1982-85, and increased recharge from record flow in the Beaver River during 1983-84. Water levels have generally continued to decline since 1985. The water level in well (C-25-10) 26caa-1, located 15 miles north of Milford, and well (C-30-13) 34bba-1, located 23 miles southwest of Milford, shows less than 2 feet of change since 1940. Water levels are stable in these areas because there is no withdrawal for irrigation.

Precipitation at Black Rock in 1996 was 7.60 inches, which is 0.13 inch less than for 1995 and 1.35 inches less than the 1952-96 average annual precipitation.

Discharge of the Beaver River in 1996 was about 26,500 acre-feet, which is 14,800 acre-feet less than the 1995 discharge and 2,800 acre-feet less than the 1931-96 average annual discharge. The concentration of dissolved solids in water from well (C-28-11) 25dcd-1 increased from less than 600 milligrams per liter in the 1950's to about 1,600 milligrams per liter in 1996.





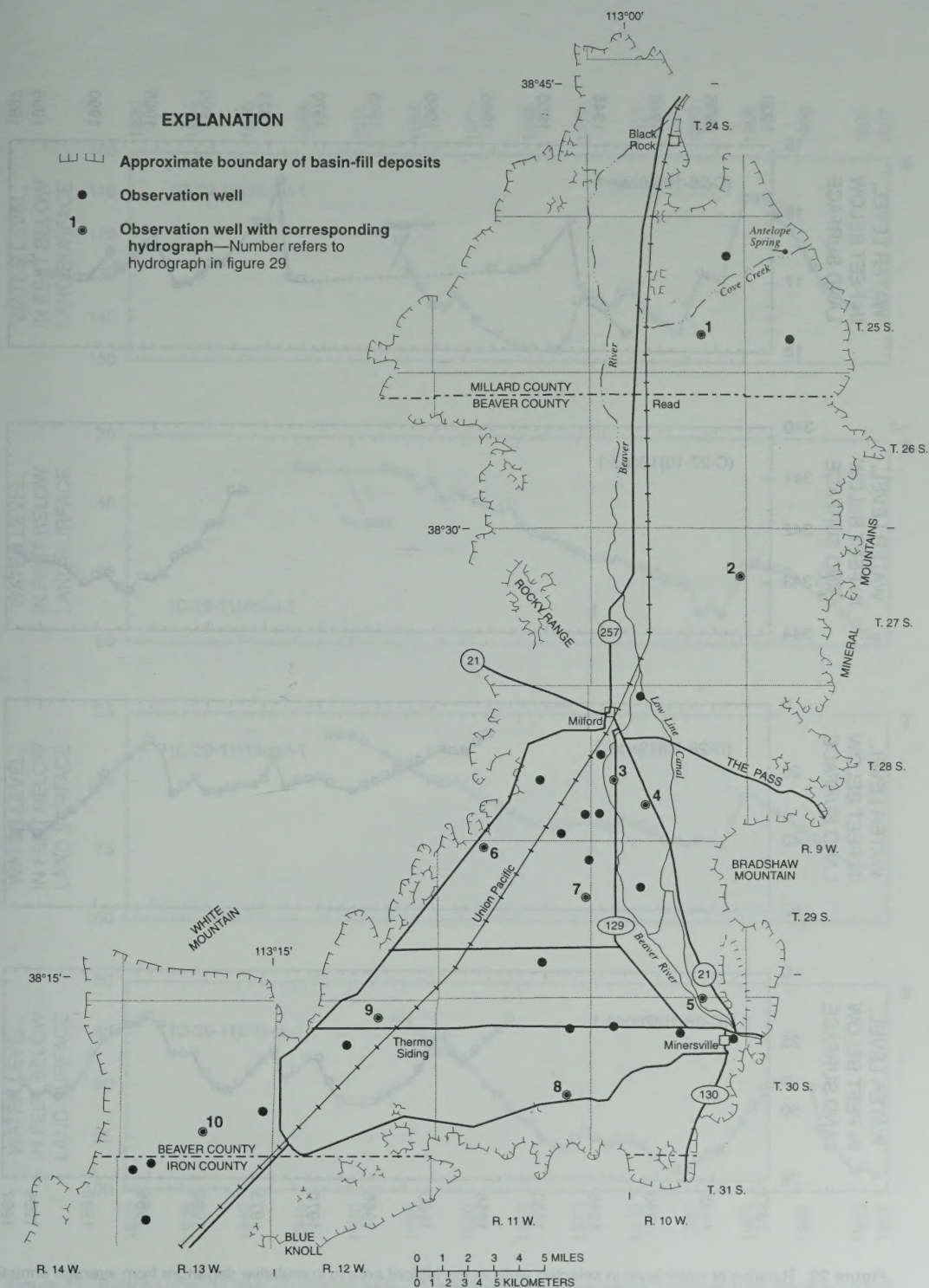
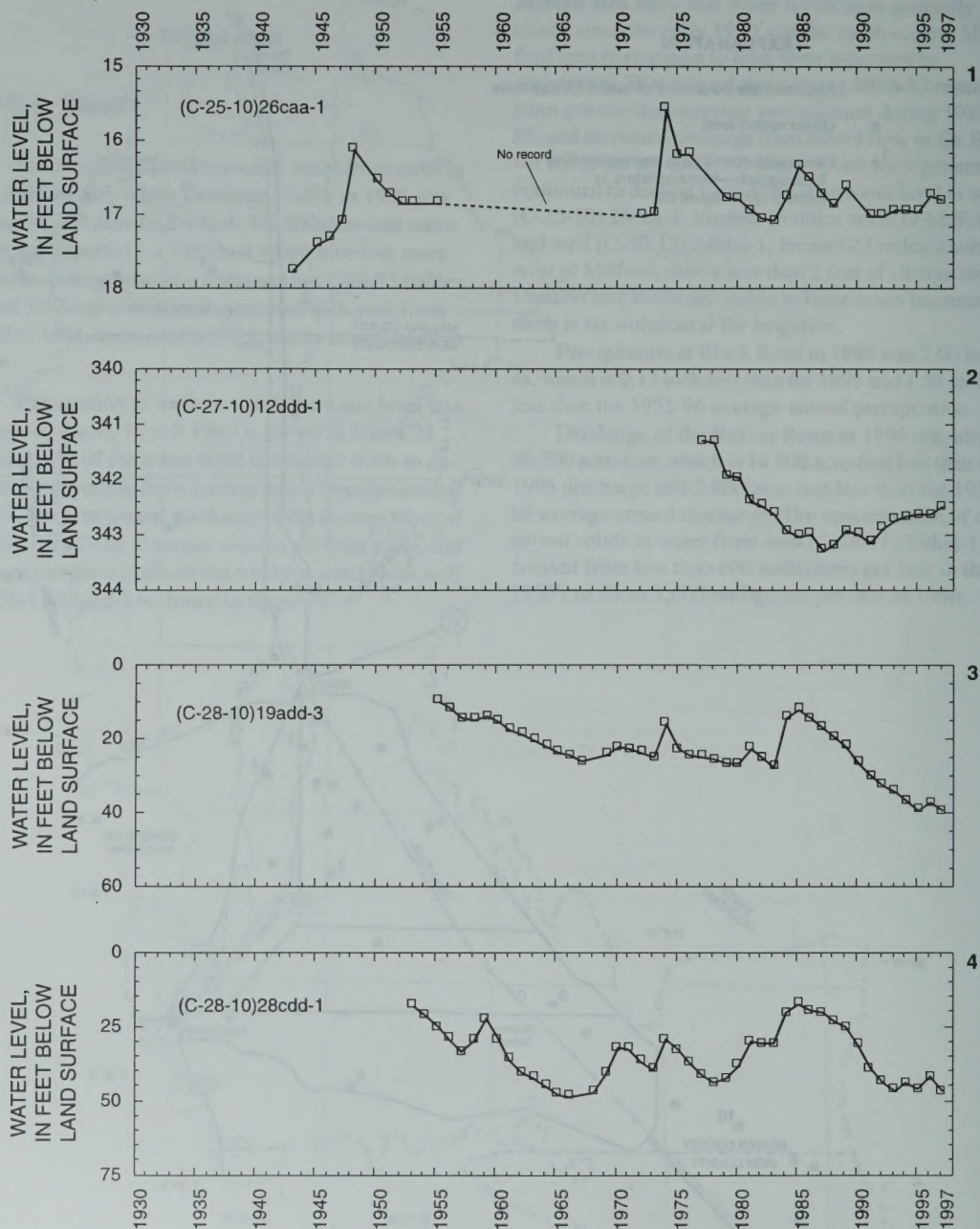
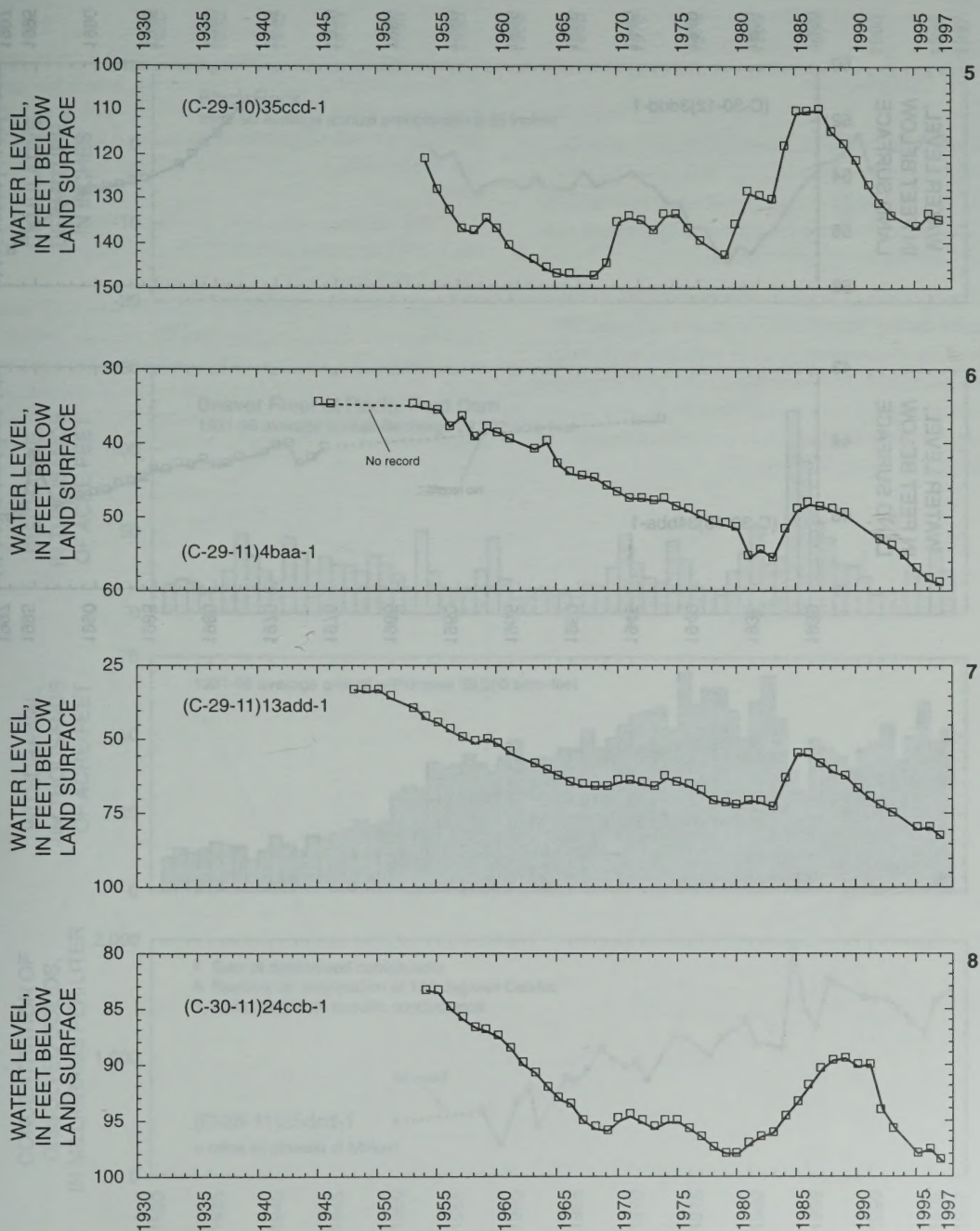


Figure 28. Location of wells in the Milford area in which the water level was measured during March 1997.



**Figure 29.** Relation of water level in selected wells in the Milford area to cumulative departure from average annual precipitation at Black Rock, to annual discharge of the Beaver River at Rocky Ford Dam, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-28-11)25dcd-1.





**Figure 29.** Relation of water level in selected wells in the Milford area to cumulative departure from average annual precipitation at Black Rock, to annual discharge of the Beaver River at Rocky Ford Dam, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-28-11)25dcd-1—Continued.

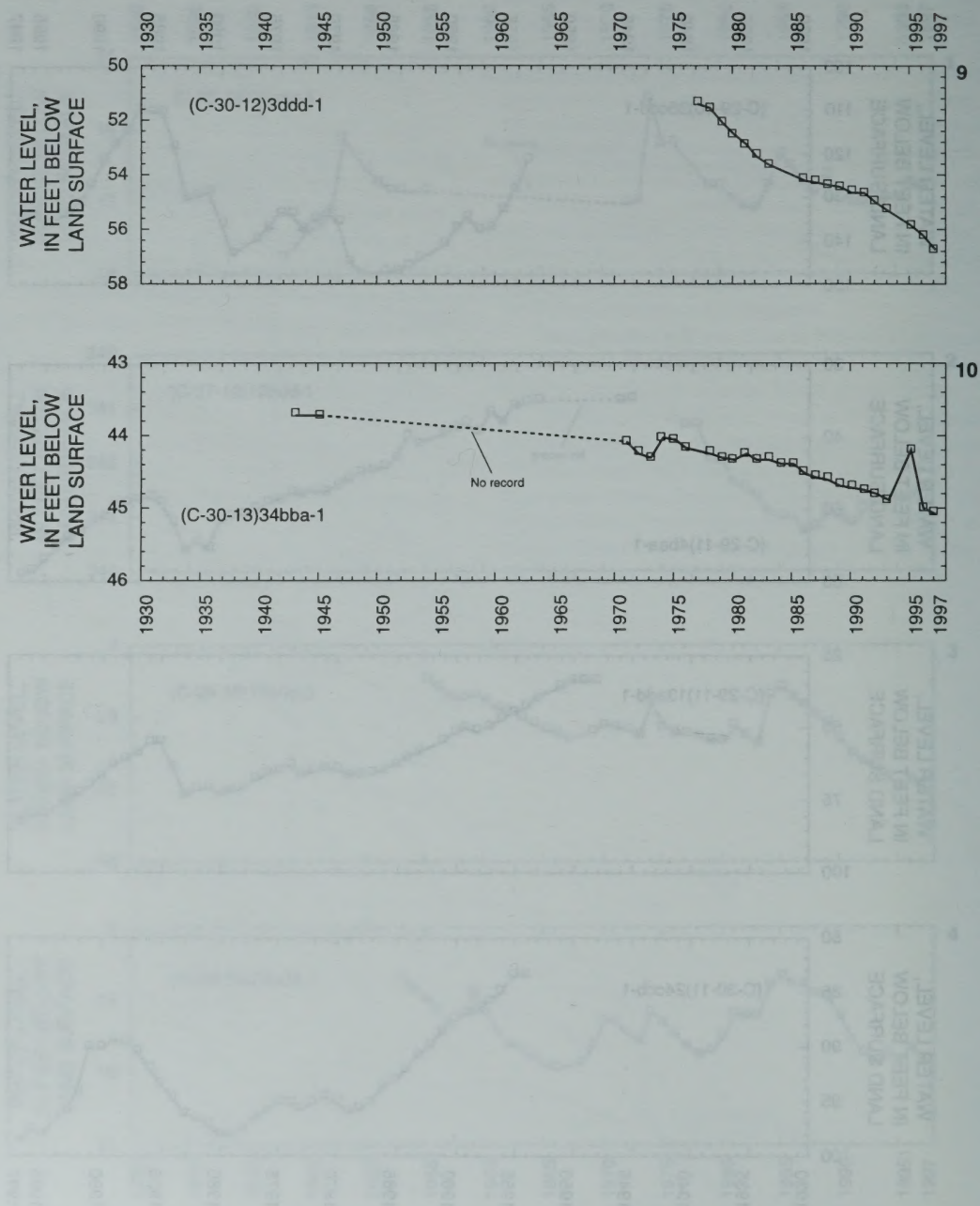
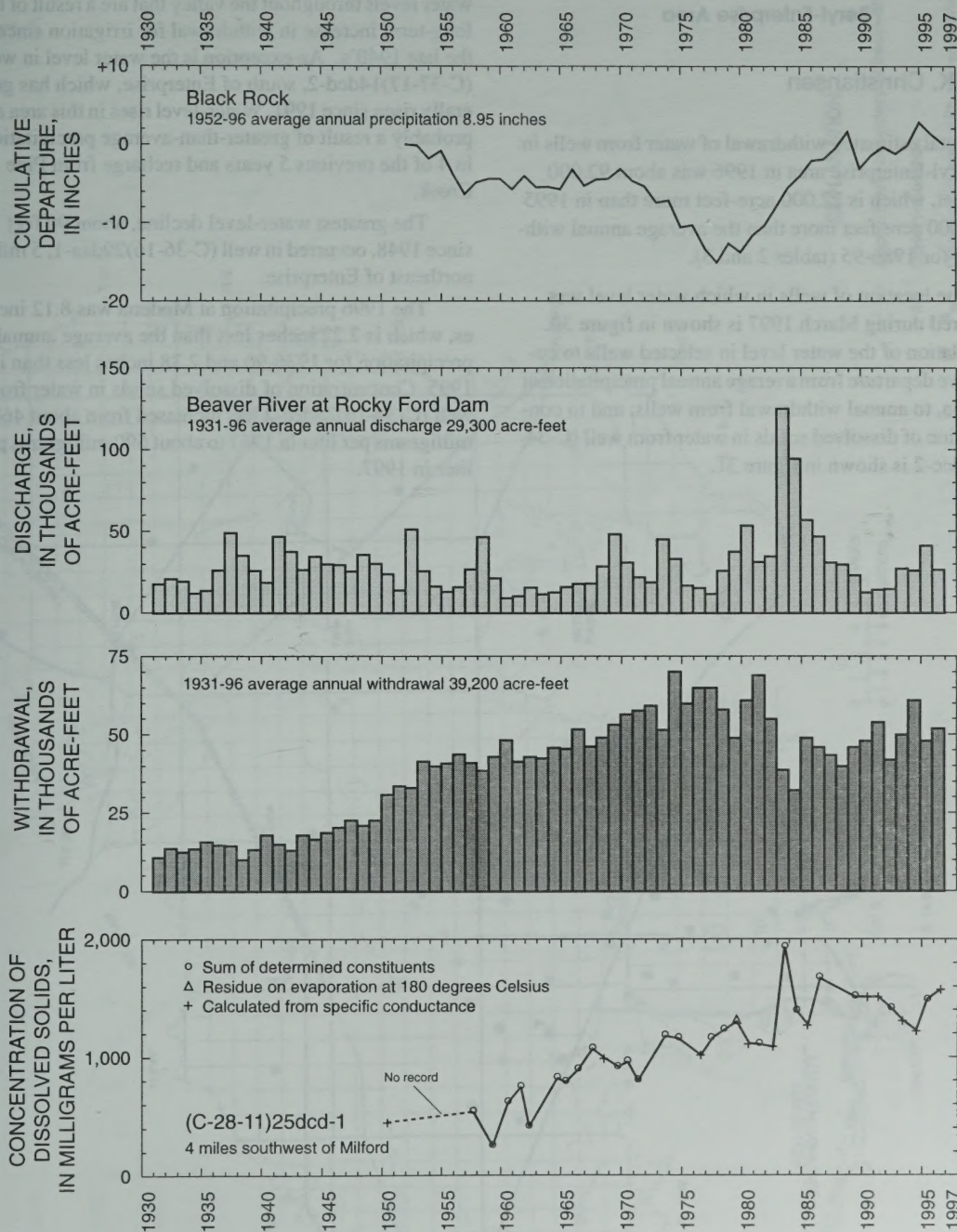


Figure 29. Relation of water level in selected wells in the Milford area to cumulative departure from average annual precipitation at Black Rock, to annual discharge of the Beaver River at Rocky Ford Dam, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-28-11)25dcd-1—Continued.





**Figure 29.** Relation of water level in selected wells in the Milford area to cumulative departure from average annual precipitation at Black Rock, to annual discharge of the Beaver River at Rocky Ford Dam, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-28-11)25dcd-1—Continued.

## ESCALANTE VALLEY

### Beryl-Enterprise Area

By H.K. Christiansen

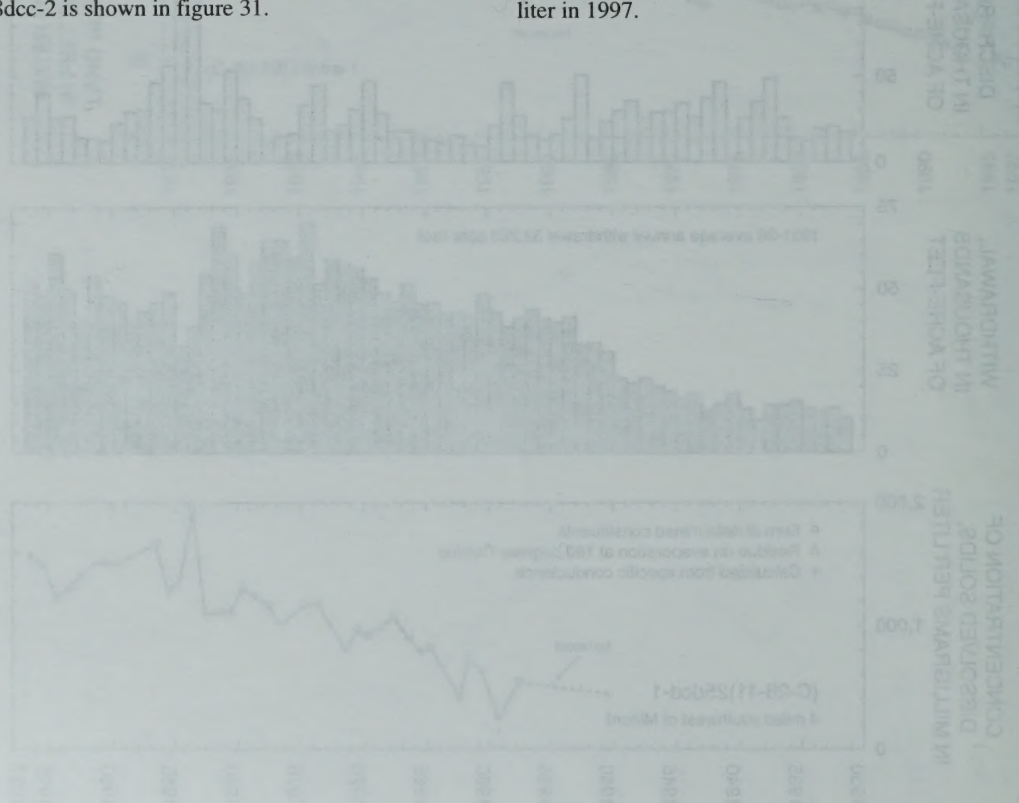
Total estimated withdrawal of water from wells in the Beryl-Enterprise area in 1996 was about 92,000 acre-feet, which is 22,000 acre-feet more than in 1995 and 9,000 acre-feet more than the average annual withdrawal for 1986-95 (tables 2 and 3).

The location of wells in which water level was measured during March 1997 is shown in figure 30. The relation of the water level in selected wells to cumulative departure from average annual precipitation at Modena, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-34-16)28dcc-2 is shown in figure 31.

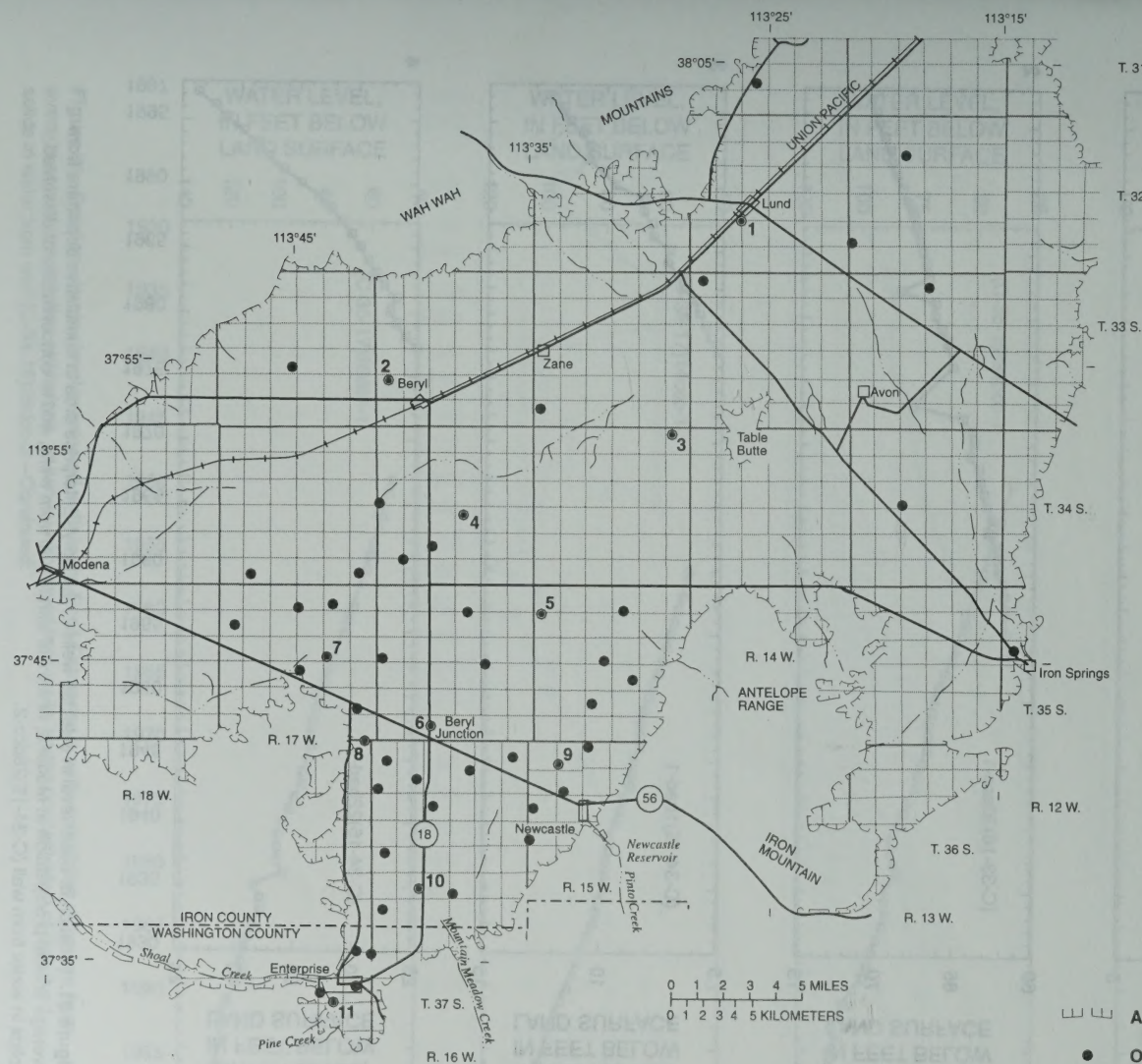
Long-term hydrographs for selected wells in the Beryl-Enterprise area show a general decline in March water levels throughout the valley that are a result of the long-term increase in withdrawal for irrigation since the late 1940's. An exception is the water level in well (C-37-17)14dcd-2, south of Enterprise, which has generally risen since 1991. Water-level rises in this area are probably a result of greater-than-average precipitation in 4 of the previous 5 years and recharge from Pine Creek.

The greatest water-level decline, about 90 feet since 1948, occurred in well (C-36-16)29daa-1, 5 miles northeast of Enterprise.

The 1996 precipitation at Modena was 8.12 inches, which is 2.22 inches less than the average annual precipitation for 1936-96 and 2.38 inches less than in 1995. Concentration of dissolved solids in water from well (C-34-16)28dcc-2 has increased from about 460 milligrams per liter in 1967 to about 690 milligrams per liter in 1997.



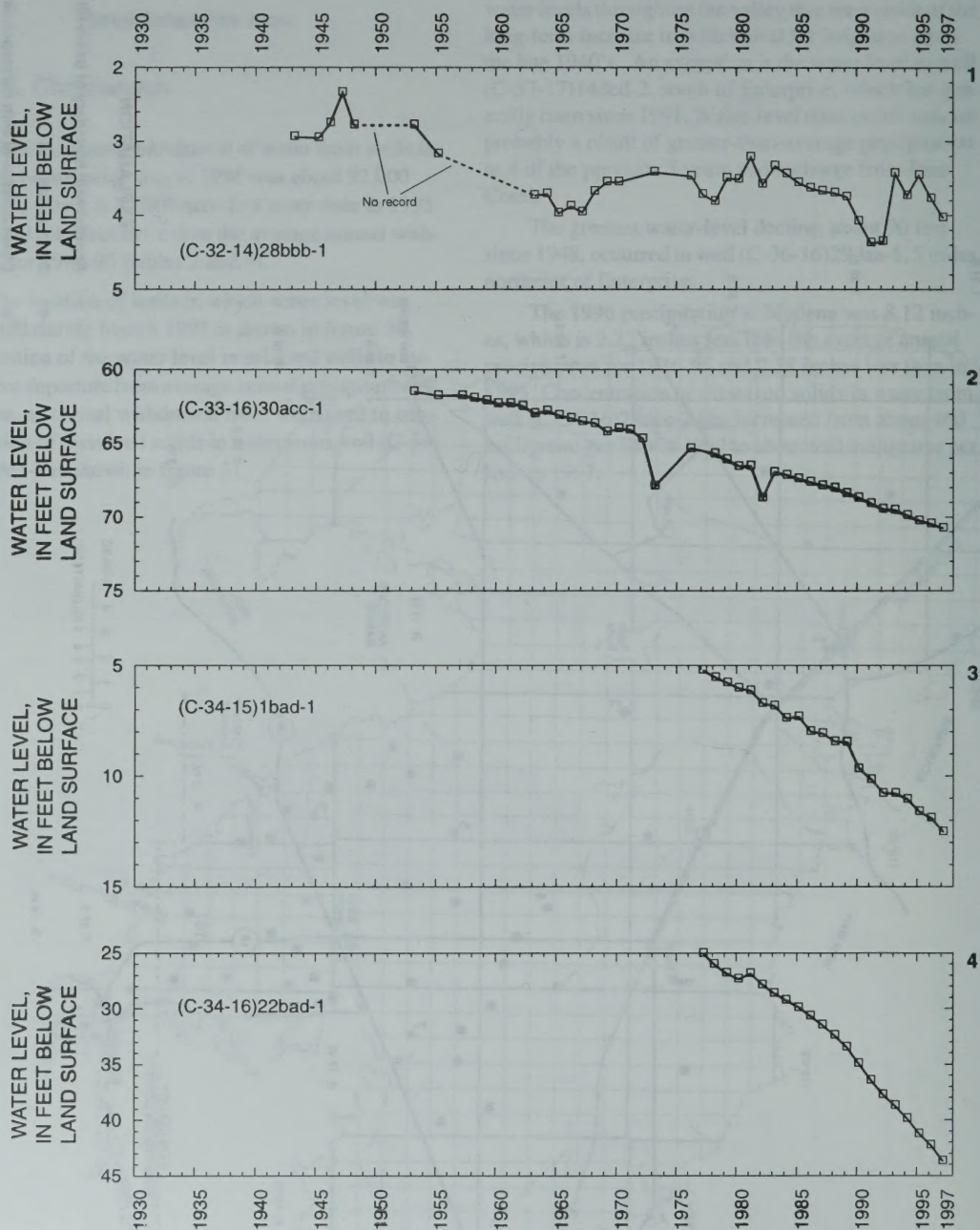




# EXPLANATION

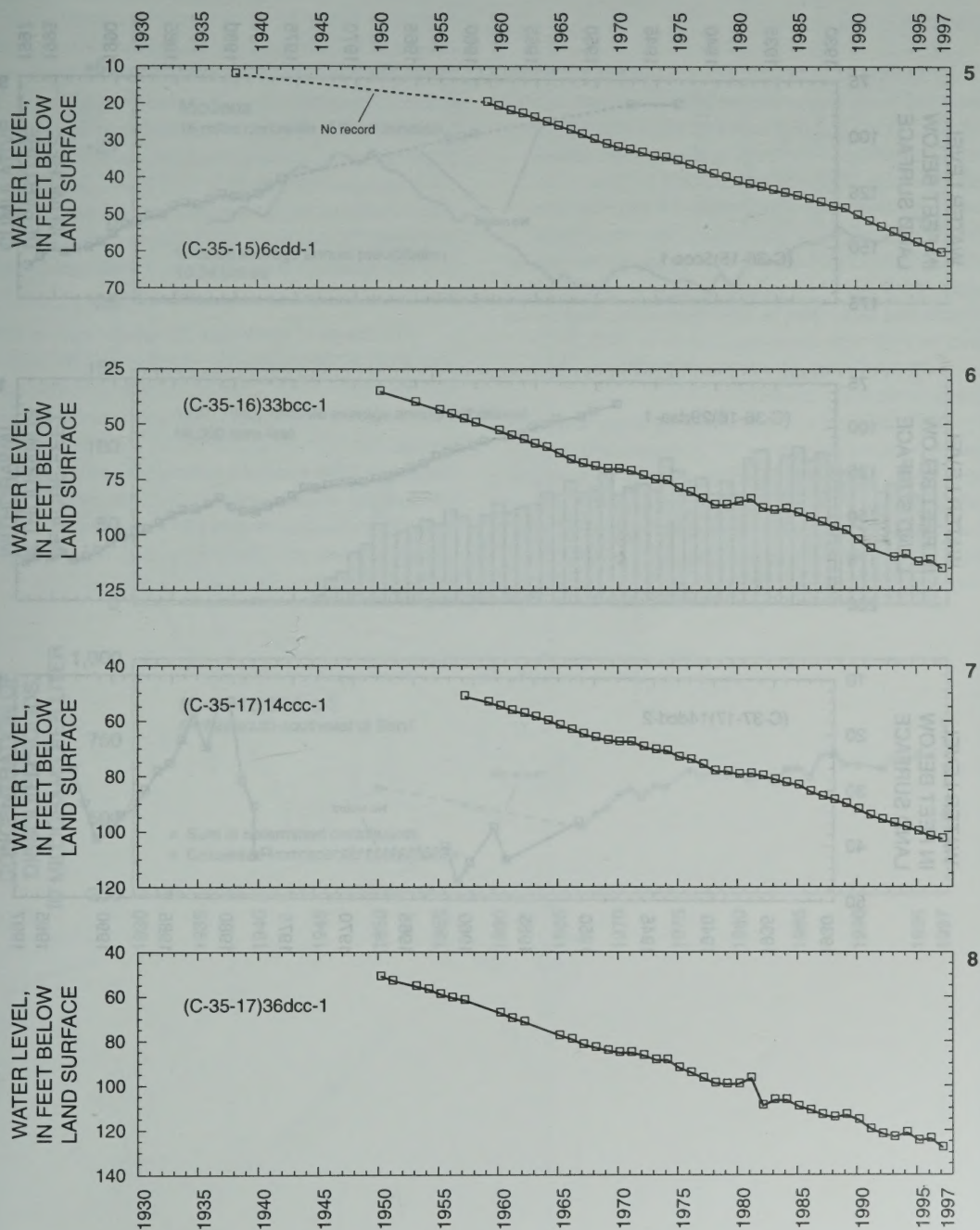
- Approximate boundary of basin-fill deposits
- Observation well
- Observation well with corresponding hydrograph—Number refers to hydrograph in figure 31

Figure 30. Location of wells in the Beryl-Enterprise area in which the water level was measured during March 1997.

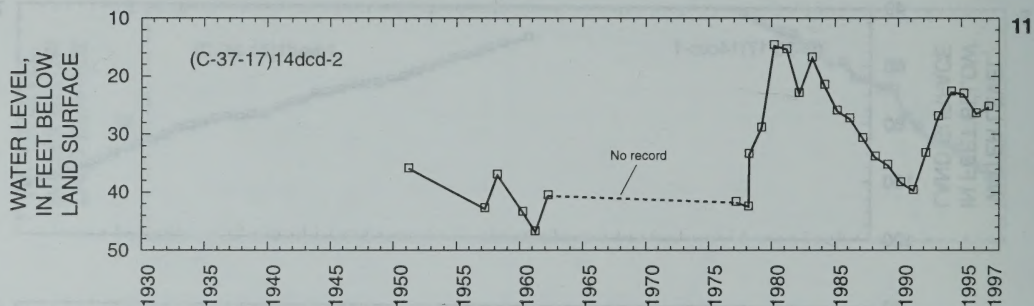
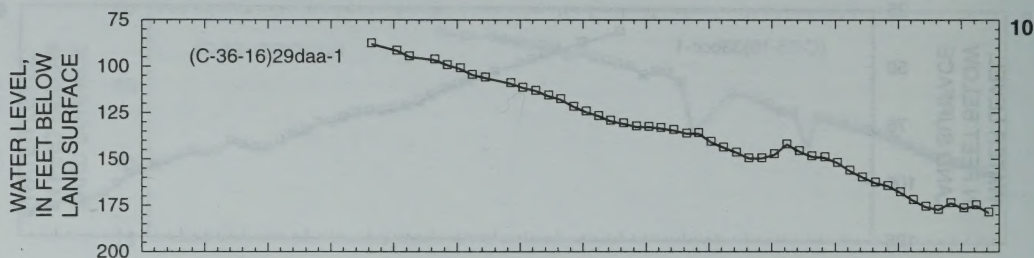
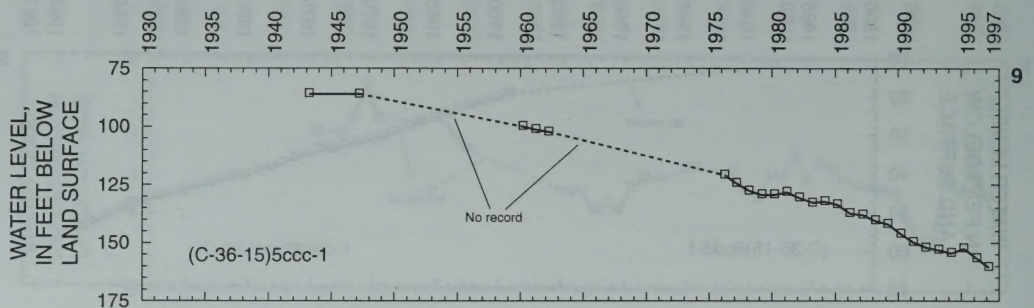


**Figure 31.** Relation of water level in selected wells in the Beryl-Enterprise area to cumulative departure from average annual precipitation at Modena, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-34-16)28dcc-2.



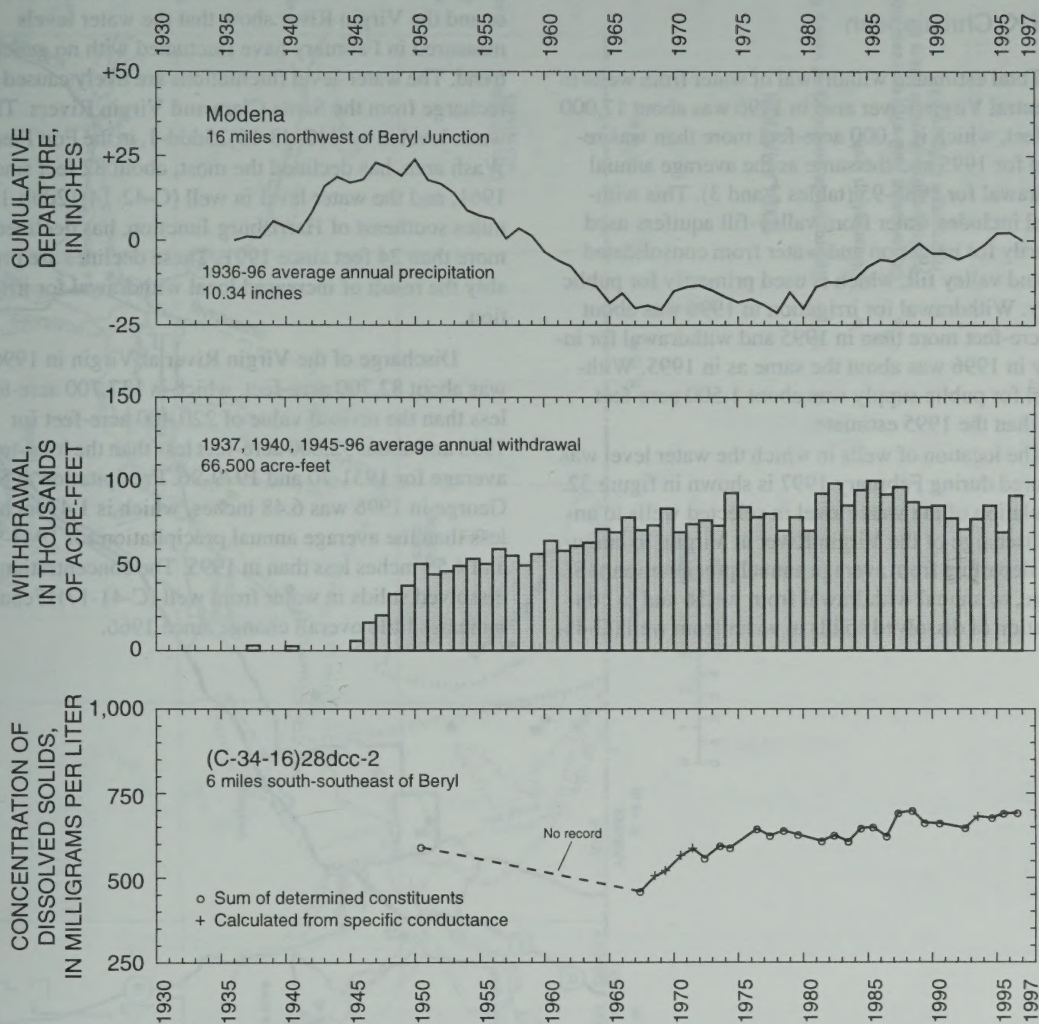


**Figure 31.** Relation of water level in selected wells in the Beryl-Enterprise area to cumulative departure from average annual precipitation at Modena, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-34-16)28dcc-2—Continued.



**Figure 31.** Relation of water level in selected wells in the Beryl-Enterprise area to cumulative departure from average annual precipitation at Modena, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-34-16)28dcc-2—Continued.





**Figure 31.** Relation of water level in selected wells in the Beryl-Enterprise area to cumulative departure from average annual precipitation at Modena, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-34-16)28dcc-2—Continued.

## CENTRAL VIRGIN RIVER AREA

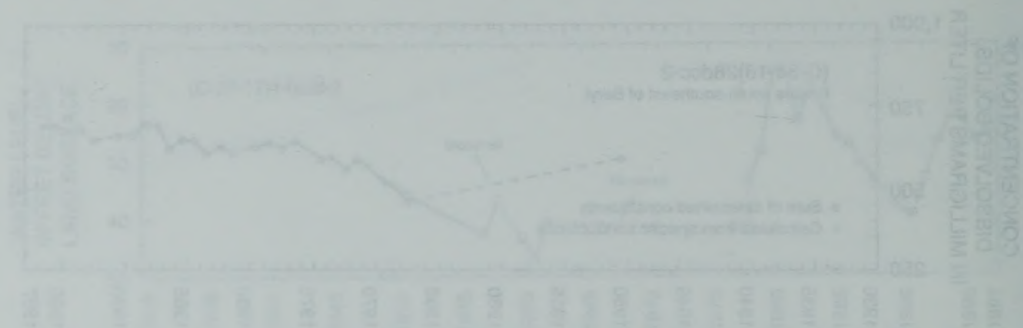
By H.K. Christiansen

Total estimated withdrawal of water from wells in the central Virgin River area in 1996 was about 17,000 acre-feet, which is 2,000 acre-feet more than was reported for 1995 and the same as the average annual withdrawal for 1986-95 (tables 2 and 3). This withdrawal includes water from valley-fill aquifers used primarily for irrigation and water from consolidated rock and valley fill, which is used primarily for public supply. Withdrawal for irrigation in 1996 was about 300 acre-feet more than in 1995 and withdrawal for industry in 1996 was about the same as in 1995. Withdrawal for public supply was about 1,500 acre-feet more than the 1995 estimate.

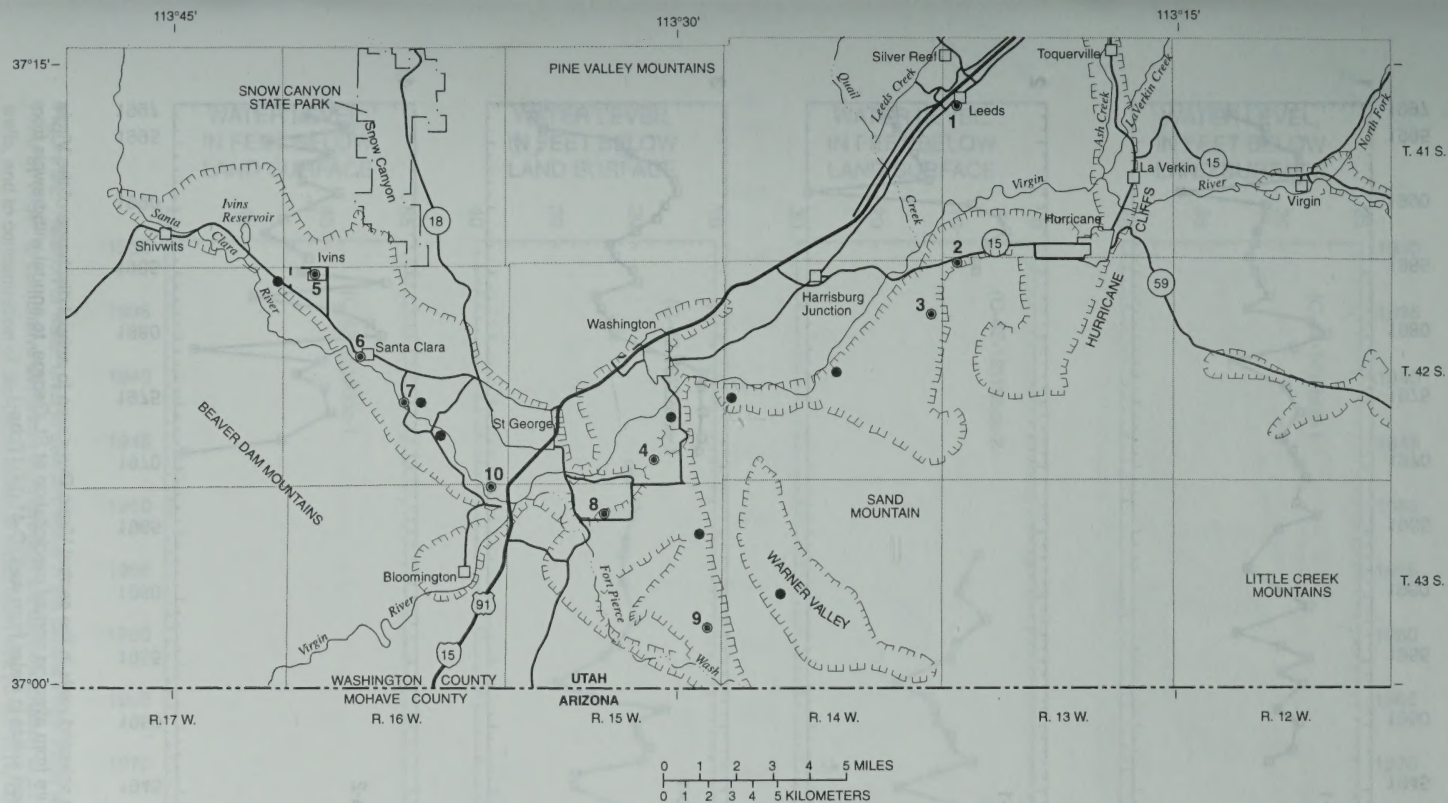
The location of wells in which the water level was measured during February 1997 is shown in figure 32. The relation of the water level in selected wells to annual discharge of the Virgin River at Virgin, to cumulative departure from average annual precipitation at St. George, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-41-

17)17cba-1 is shown in figure 33. Long-term hydrographs for selected wells along the Santa Clara River and the Virgin River show that the water levels measured in February have fluctuated with no general trend. The water-level fluctuations are likely caused by recharge from the Santa Clara and Virgin Rivers. The water level in well (C-43-15)25ddd-1, in the Fort Pierce Wash area, has declined the most, about 82 feet since 1961; and the water level in well (C-42-14)12dbb-1, 4 miles southeast of Harrisburg Junction, has declined more than 24 feet since 1991. These declines are probably the result of increased local withdrawal for irrigation.

Discharge of the Virgin River at Virgin in 1996 was about 82,700 acre-feet, which is 137,700 acre-feet less than the revised value of 220,400 acre-feet for 1995 and about 52,800 acre-feet less than the long-term average for 1931-70 and 1979-96. Precipitation at St. George in 1996 was 6.48 inches, which is 1.47 inches less than the average annual precipitation for 1947-96 and 4.55 inches less than in 1995. The concentration of dissolved solids in water from well (C-41-17)17cba-1 indicates little overall change since 1966.



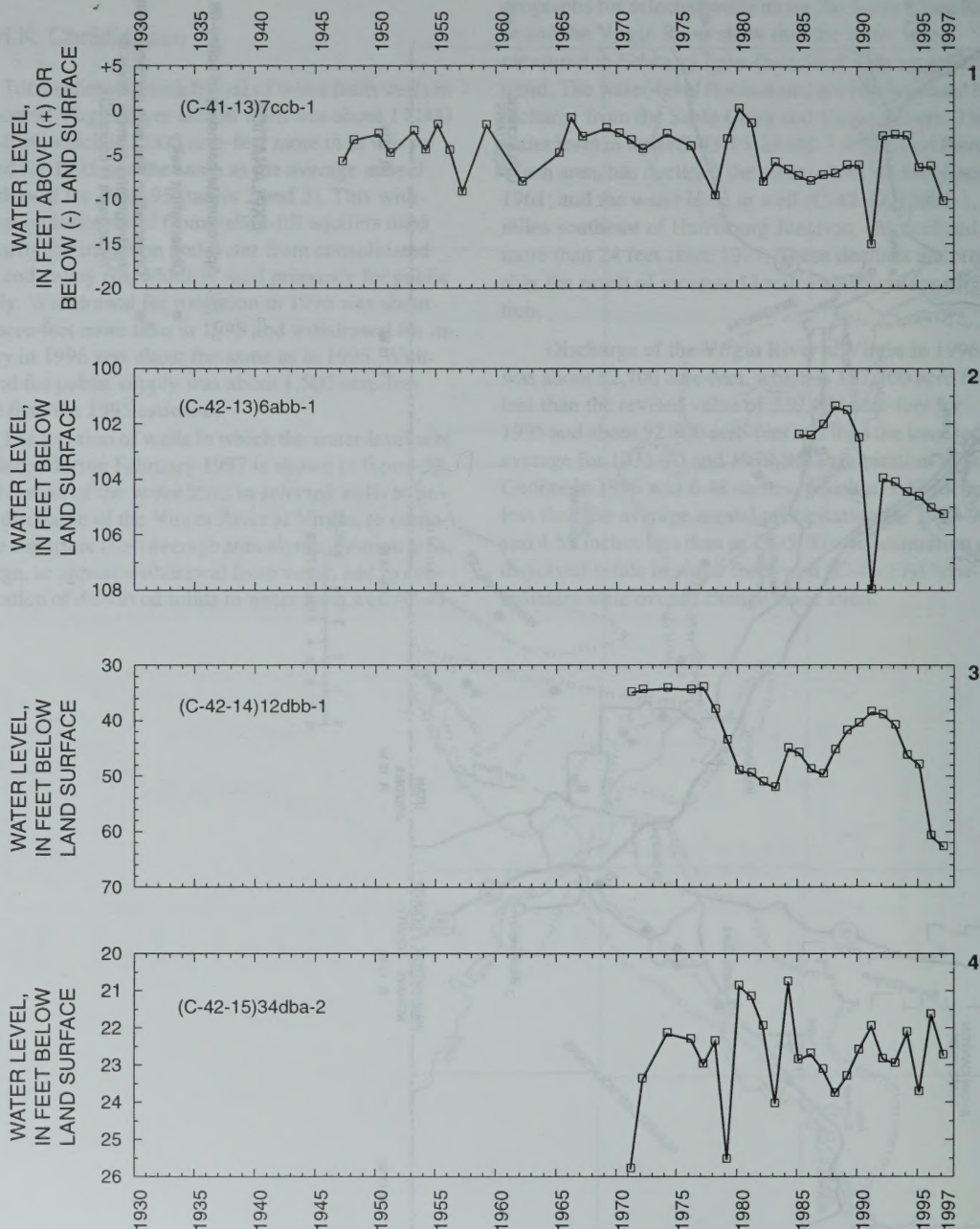




# EXPLANATION

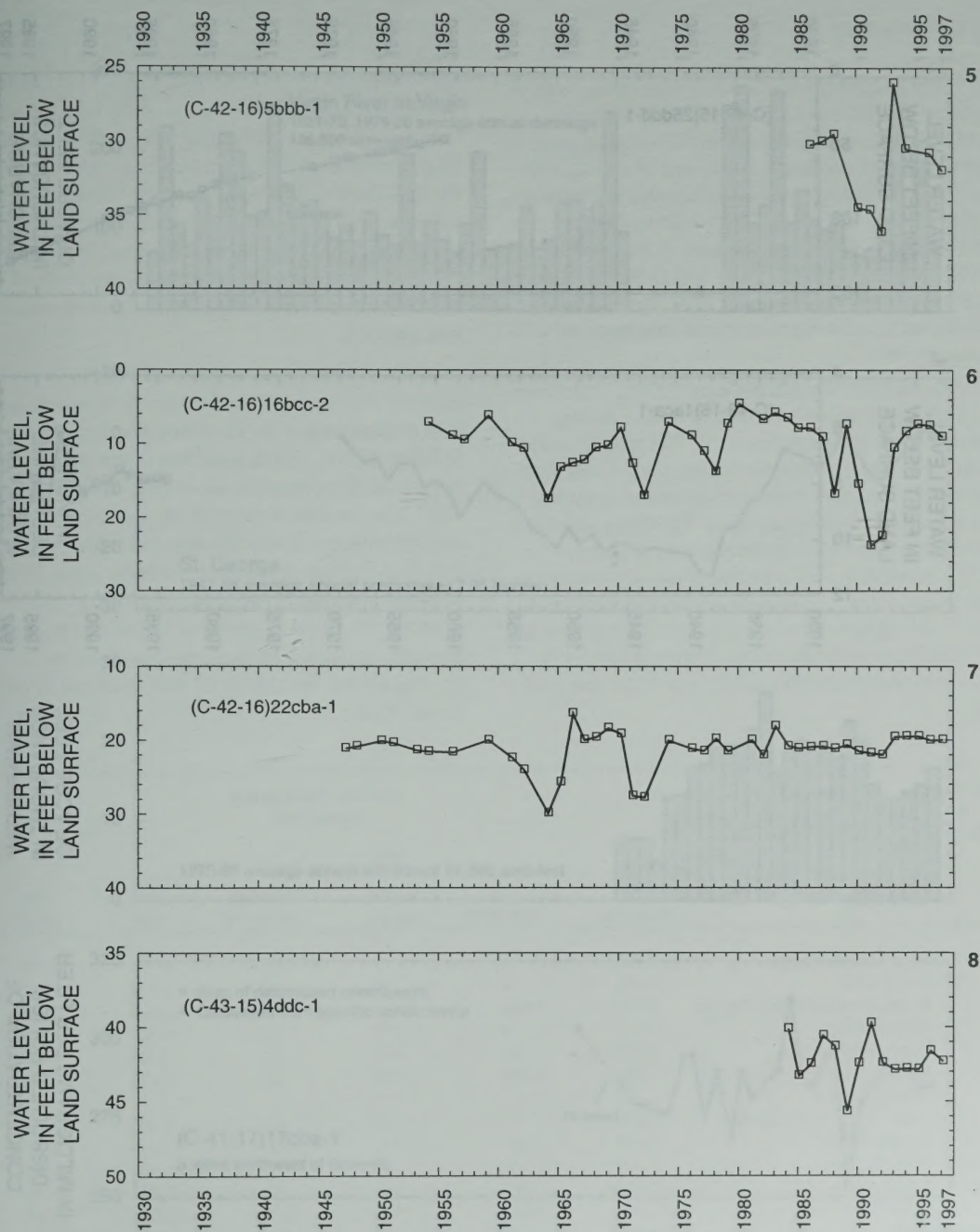
- Approximate boundary of valley-fill deposits
- Observation well
- Observation well with corresponding hydrograph—Number refers to hydrograph in figure 33

Figure 32. Location of wells in the central Virgin River area in which the water level was measured during February 1997.

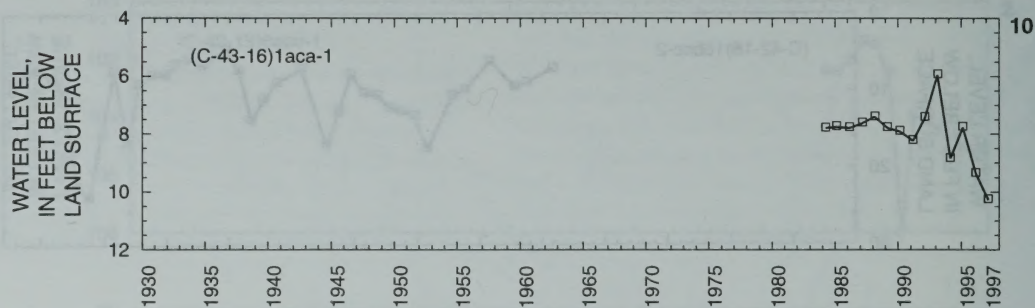
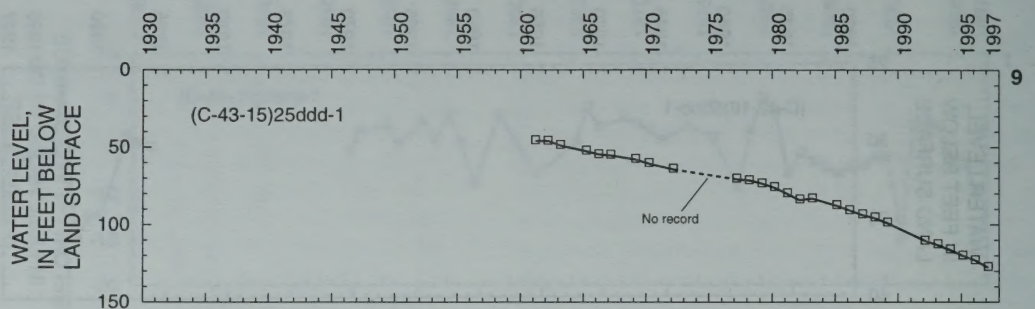


**Figure 33.** Relation of water level in selected wells in the central Virgin River area to annual discharge of the Virgin River at Virgin, to cumulative departure from average annual precipitation at St. George, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-41-17)17cba-1.



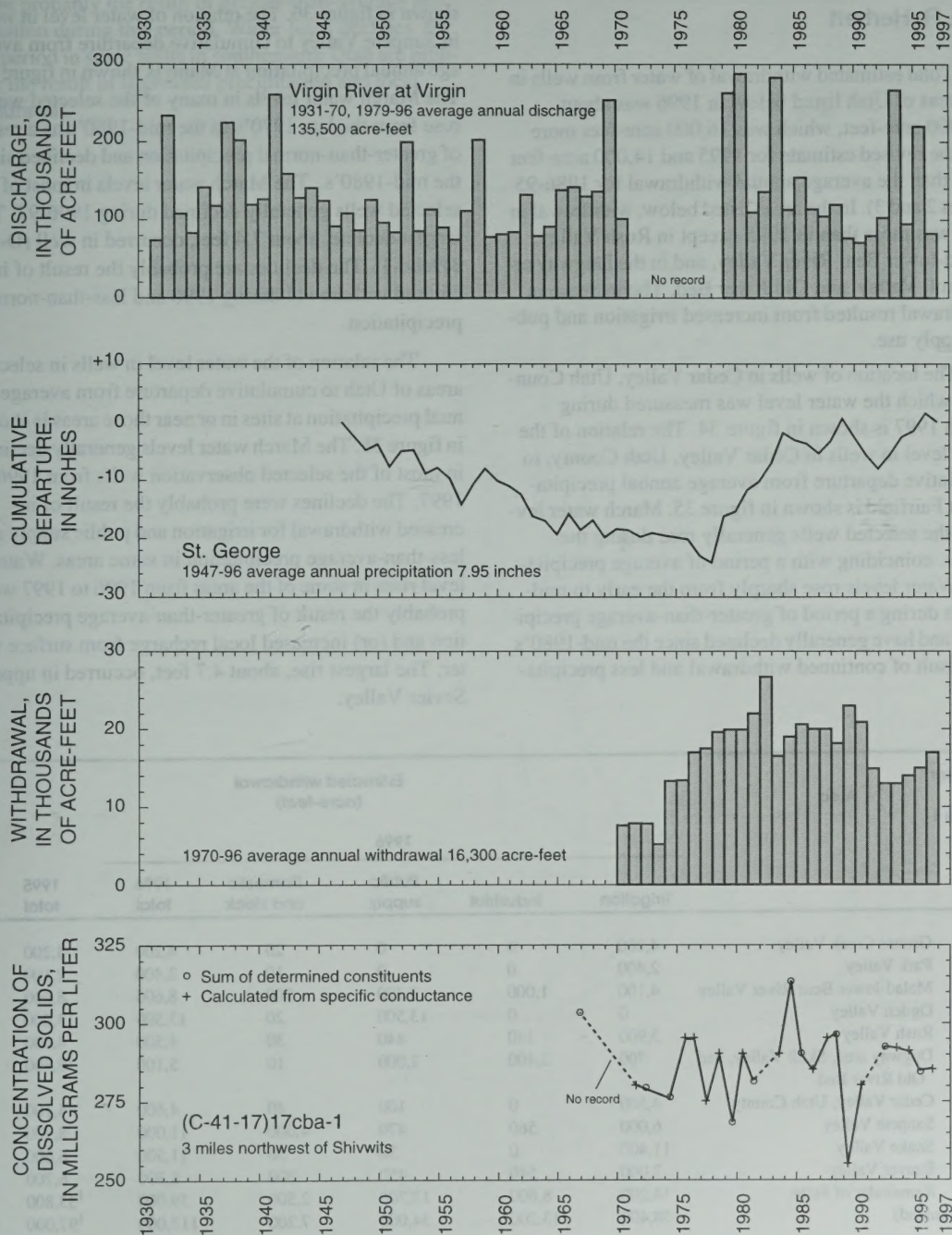


**Figure 33.** Relation of water level in selected wells in the central Virgin River area to annual discharge of the Virgin River at Virgin, to cumulative departure from average annual precipitation at St. George, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-41-17)17cba-1—Continued.



**Figure 33.** Relation of water level in selected wells in the central Virgin River area to annual discharge of the Virgin River at Virgin, to cumulative departure from average annual precipitation at St. George, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-41-17)17cba-1—Continued.





**Figure 33.** Relation of water level in selected wells in the central Virgin River area to annual discharge of the Virgin River at Virgin, to cumulative departure from average annual precipitation at St. George, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-41-17)17cba-1—Continued.

## OTHER AREAS

By L.R. Herbert

Total estimated withdrawal of water from wells in the areas of Utah listed below in 1996 was about 113,000 acre-feet, which was 16,000 acre-feet more than the revised estimate for 1995 and 14,000 acre-feet more than the average annual withdrawal for 1986-95 (tables 2 and 3). In the areas listed below, withdrawal in 1996 was more than in 1995 except in Rush Valley, Malad-lower Bear River Valley, and in the Dugway area, Skull Valley, and Old River Bed. The increase in withdrawal resulted from increased irrigation and public-supply use.

The location of wells in Cedar Valley, Utah County, in which the water level was measured during March 1997 is shown in figure 34. The relation of the water level in wells in Cedar Valley, Utah County, to cumulative departure from average annual precipitation at Fairfield is shown in figure 35. March water levels in the selected wells generally rose during the 1970's, coinciding with a period of average precipitation. Water levels rose sharply from the early to mid-1980's during a period of greater-than-average precipitation and have generally declined since the mid-1980's as a result of continued withdrawal and less precipitation.

The location of wells in Sanpete Valley in which the water level was measured during March 1997 is shown in figure 36. The relation of water level in wells in Sanpete Valley to cumulative departure from average annual precipitation at Manti is shown in figure 37. The March water levels in many of the selected wells rose from the late 1970's to the mid-1980's as a result of greater-than-normal precipitation and declined since the mid-1980's. The March water levels in most of the selected wells generally declined during 1996-97. The largest decline, about 7.4 feet, occurred in well (D-17-3)9cbd-1. The declines are probably the result of increased withdrawal during 1996 and less-than-normal precipitation.

The relation of the water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas is shown in figure 38. The March water levels generally declined in most of the selected observation wells from 1996 to 1997. The declines were probably the result of increased withdrawal for irrigation and public supply and less-than-average precipitation in some areas. Water-level rises in some of the areas from 1996 to 1997 were probably the result of greater-than-average precipitation and (or) increased local recharge from surface water. The largest rise, about 4.7 feet, occurred in upper Sevier Valley.

Number in figure 1	Area	Estimated withdrawal (acre-feet)					
		1996				1996 total	1995 total
		Irrigation	Industrial	Public supply	Domestic and stock		
1	Grouse Creek Valley	4,200	0	0	20	4,200	3,200
2	Park Valley	2,400	0	0	10	2,400	2,100
4	Malad-lower Bear River Valley	4,100	1,000	3,300	200	8,600	8,600
8	Ogden Valley	0	0	13,500	20	13,500	13,000
13	Rush Valley	3,900	140	440	30	4,500	<sup>1</sup> 4,600
14	Dugway area, Skull Valley, and Old River Bed	700	2,400	2,000	10	5,100	<sup>1</sup> 5,300
15	Cedar Valley, Utah County	4,500	0	100	40	4,600	<sup>1</sup> 4,100
20	Sanpete Valley	6,000	560	470	4,000	11,000	8,900
25	Snake Valley	11,400	0	30	50	11,500	6,600
27	Beaver Valley	7,000	540	450	300	8,300	6,700
	Remainder of State	14,200	8,600	13,700	2,500	39,000	<sup>1</sup> 33,800
Total (rounded)		58,400	13,200	34,000	7,200	113,000	<sup>1</sup> 97,000

<sup>1</sup>Previously unpublished revision.



Water levels measured during March generally rose during 1993-96 in most of the "Other Areas." Rises are probably the result of greater-than-average precipitation during this period. Water-level declines for this period in some wells in southeastern Utah are probably the result of decreased precipitation and local withdrawal.

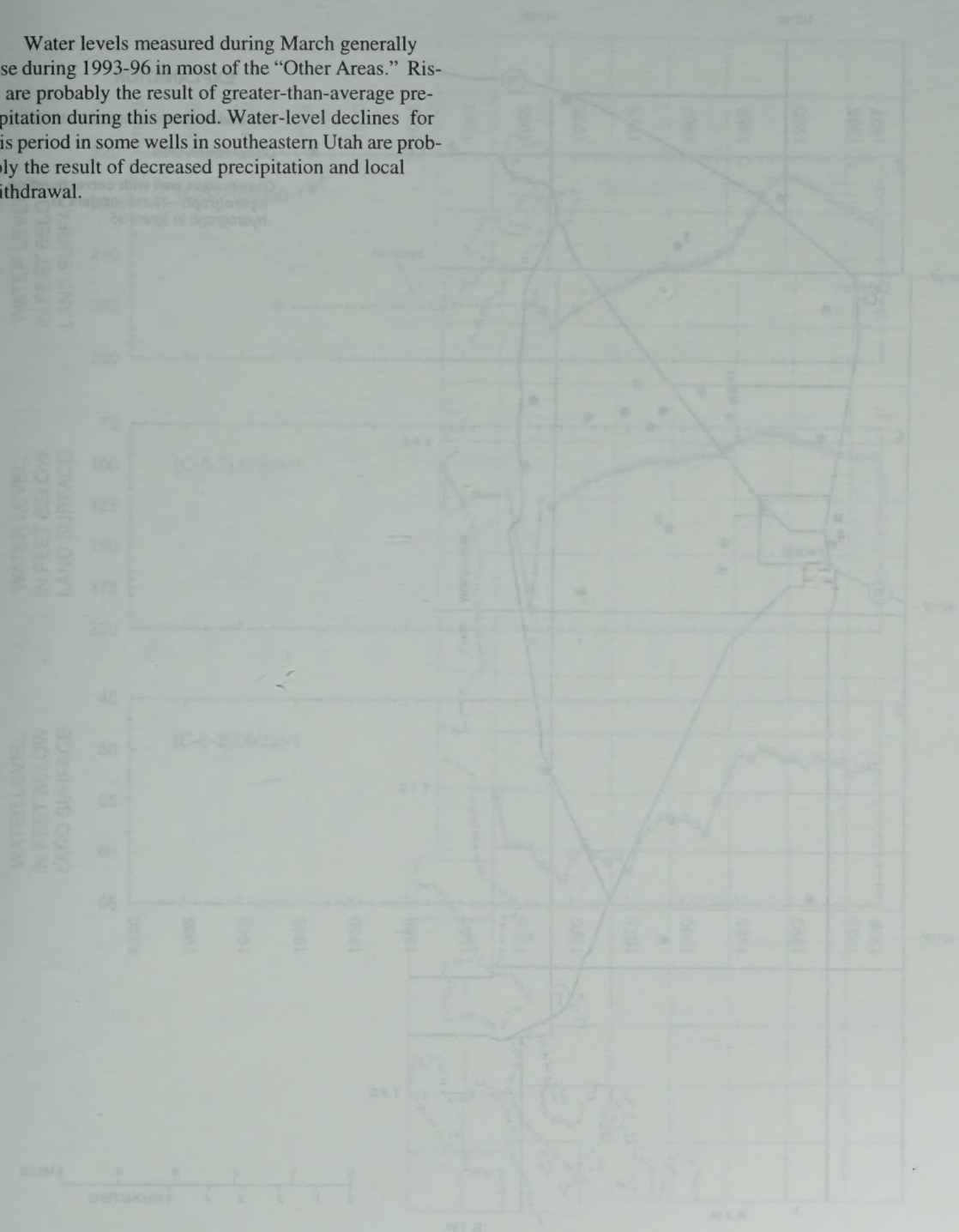
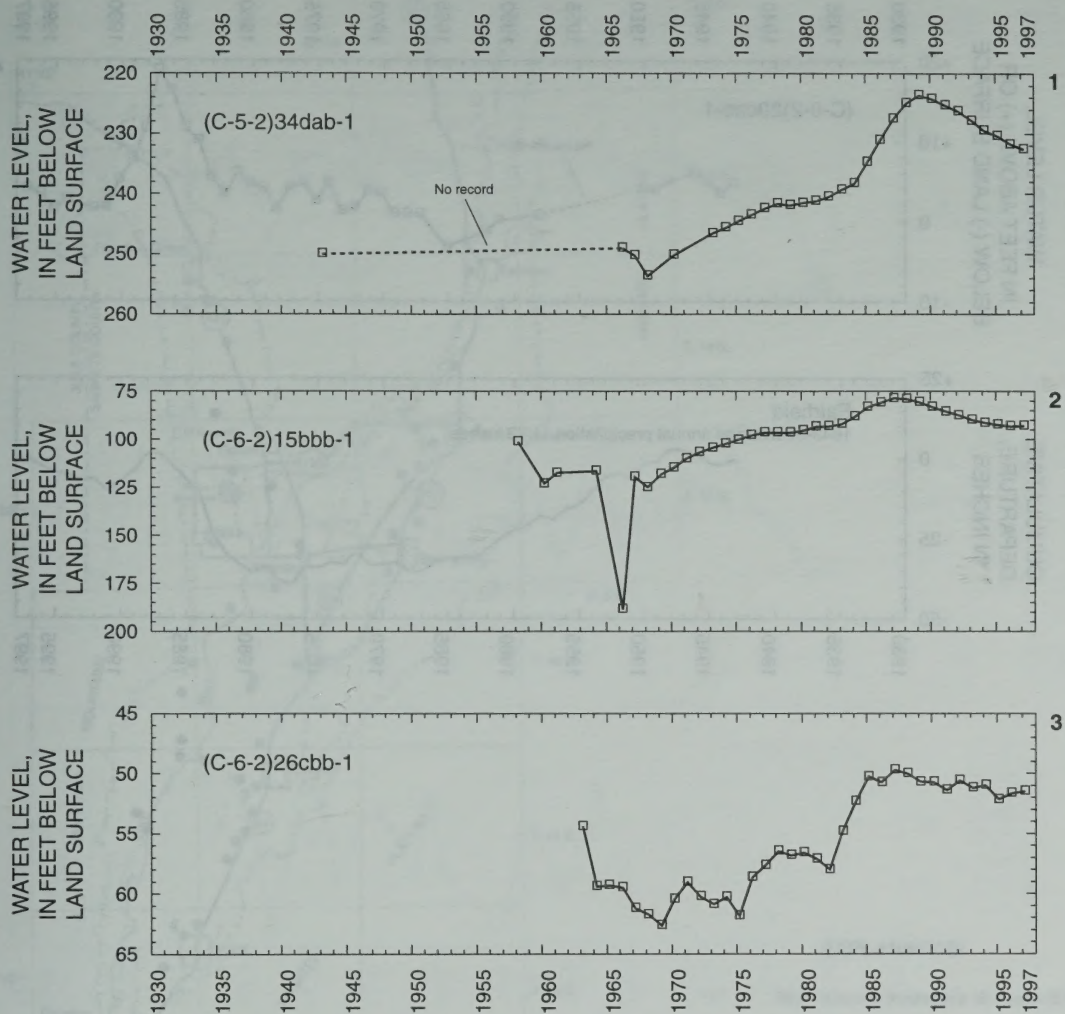


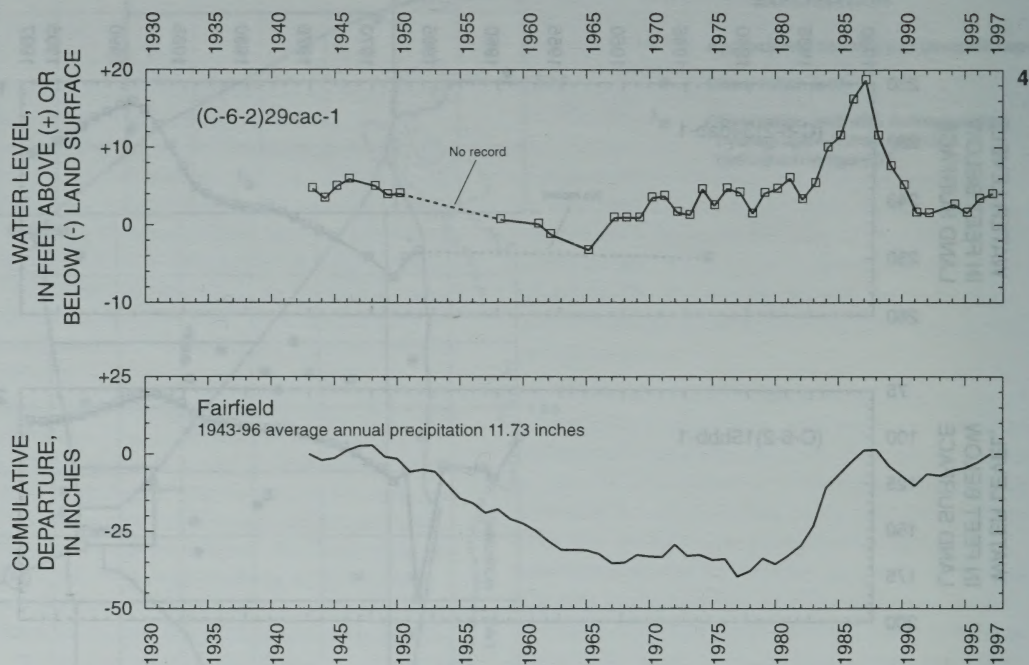
Figure 34. Location of wells in Carbon Valley, Utah County, showing the water level trends from 1920 to 1990. The water level trends are shown in the inset graphs. The water level trends are shown in the inset graphs.







**Figure 35.** Relation of water level in wells in Cedar Valley, Utah County, to cumulative departure from average annual precipitation at Fairfield.



**Figure 35.** Relation of water level in wells in Cedar Valley, Utah County, to cumulative departure from average annual precipitation at Fairfield—Continued.



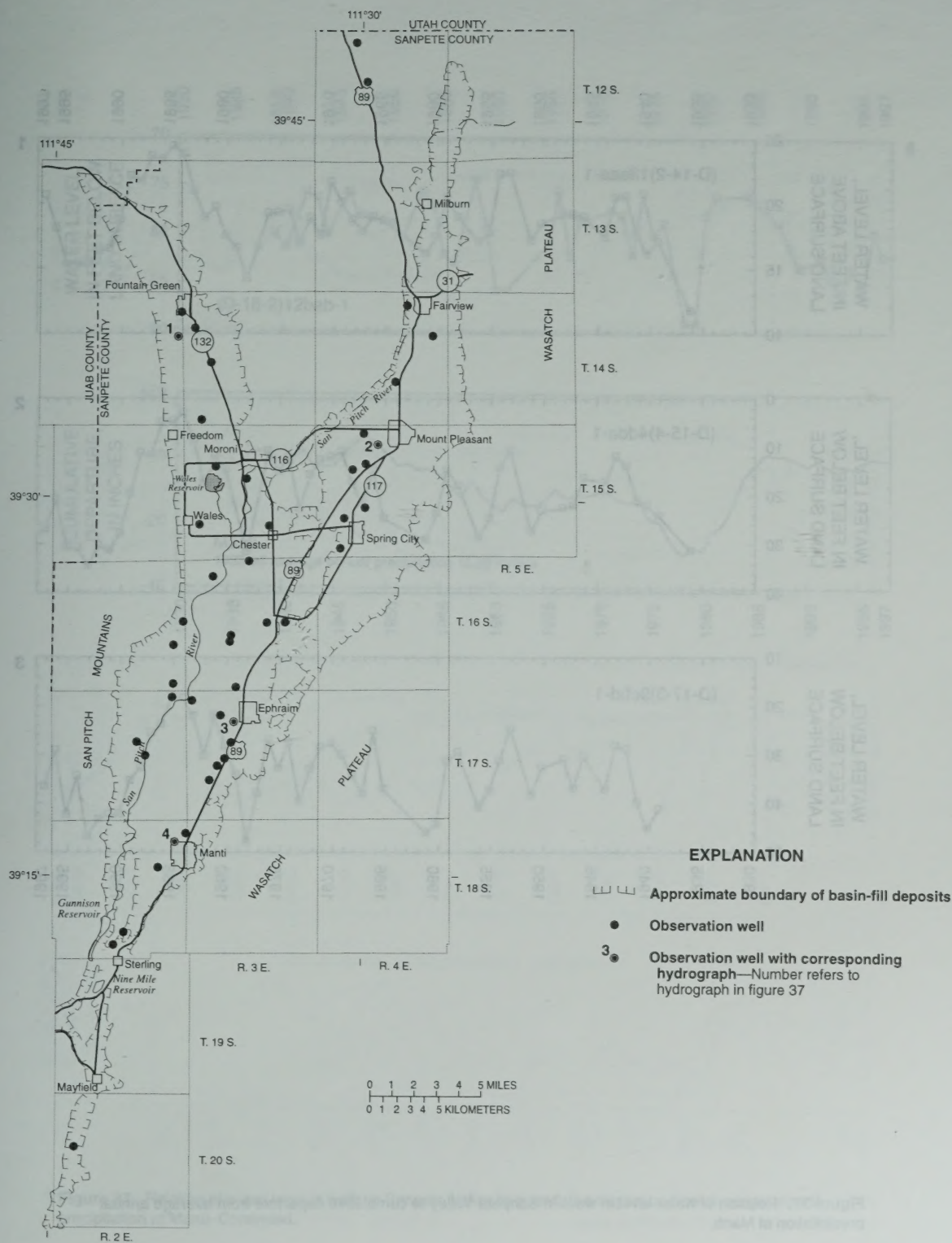
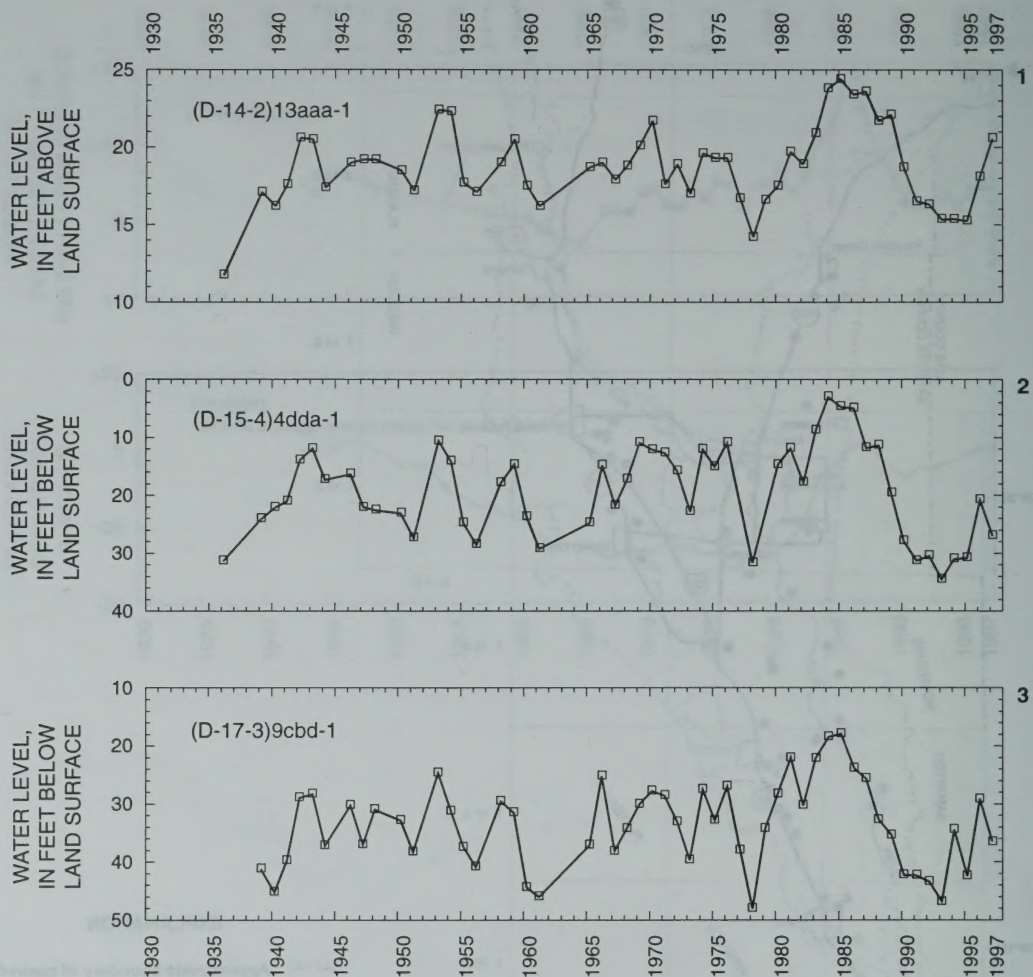
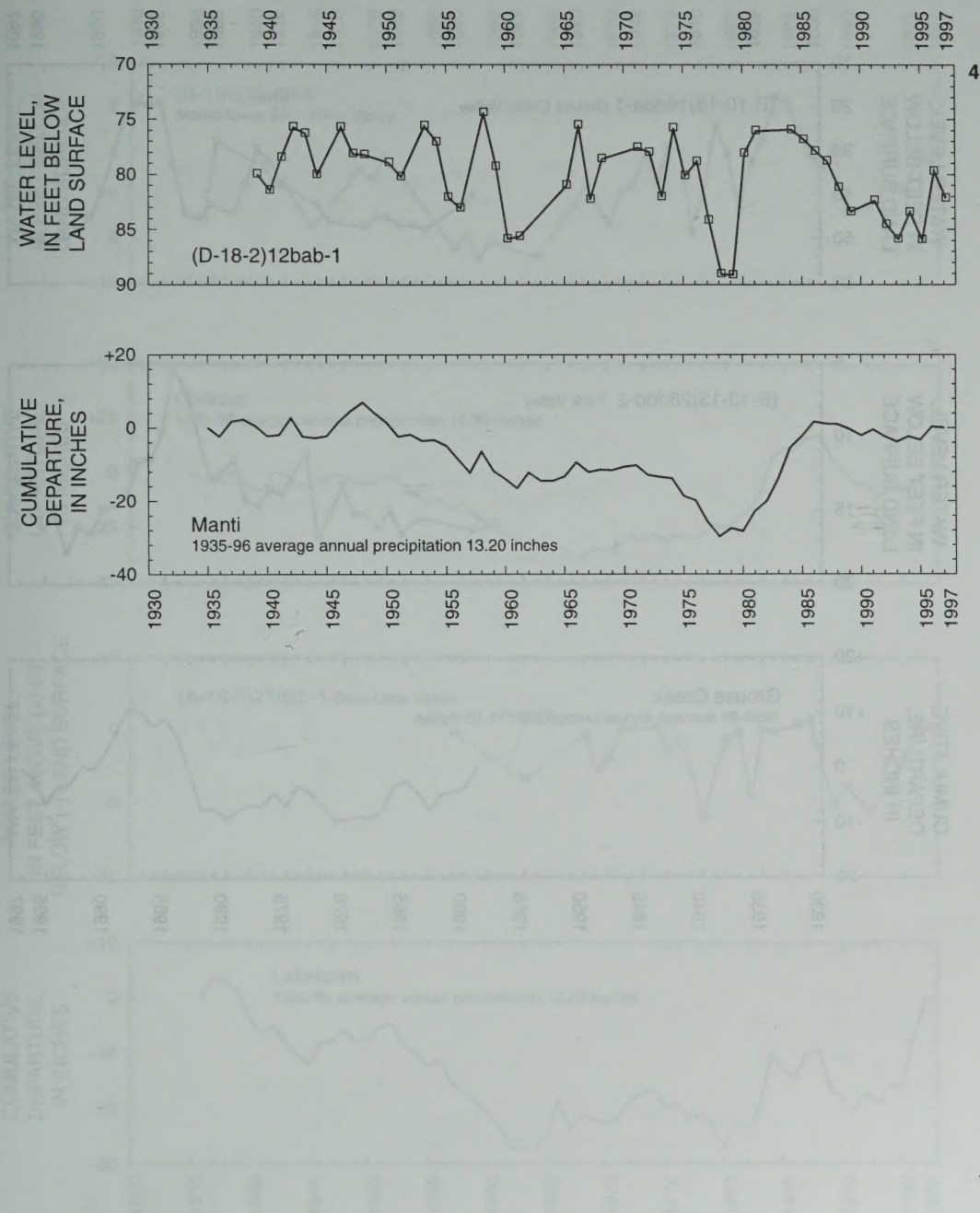


Figure 36. Location of wells in Sanpete Valley in which the water level was measured during March 1997.



**Figure 37.** Relation of water level in wells in Sanpete Valley to cumulative departure from average annual precipitation at Manti.





**Figure 37.** Relation of water level in wells in Sanpete Valley to cumulative departure from average annual precipitation at Manti—Continued.

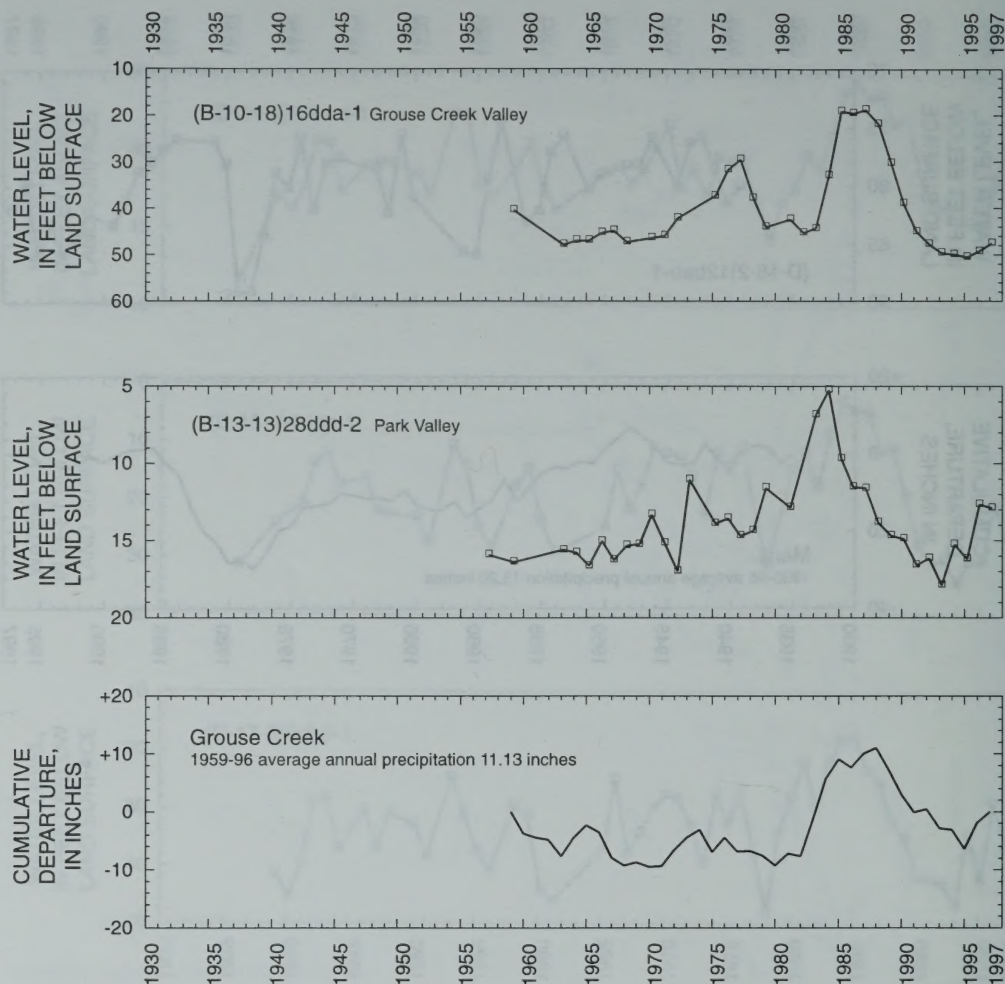
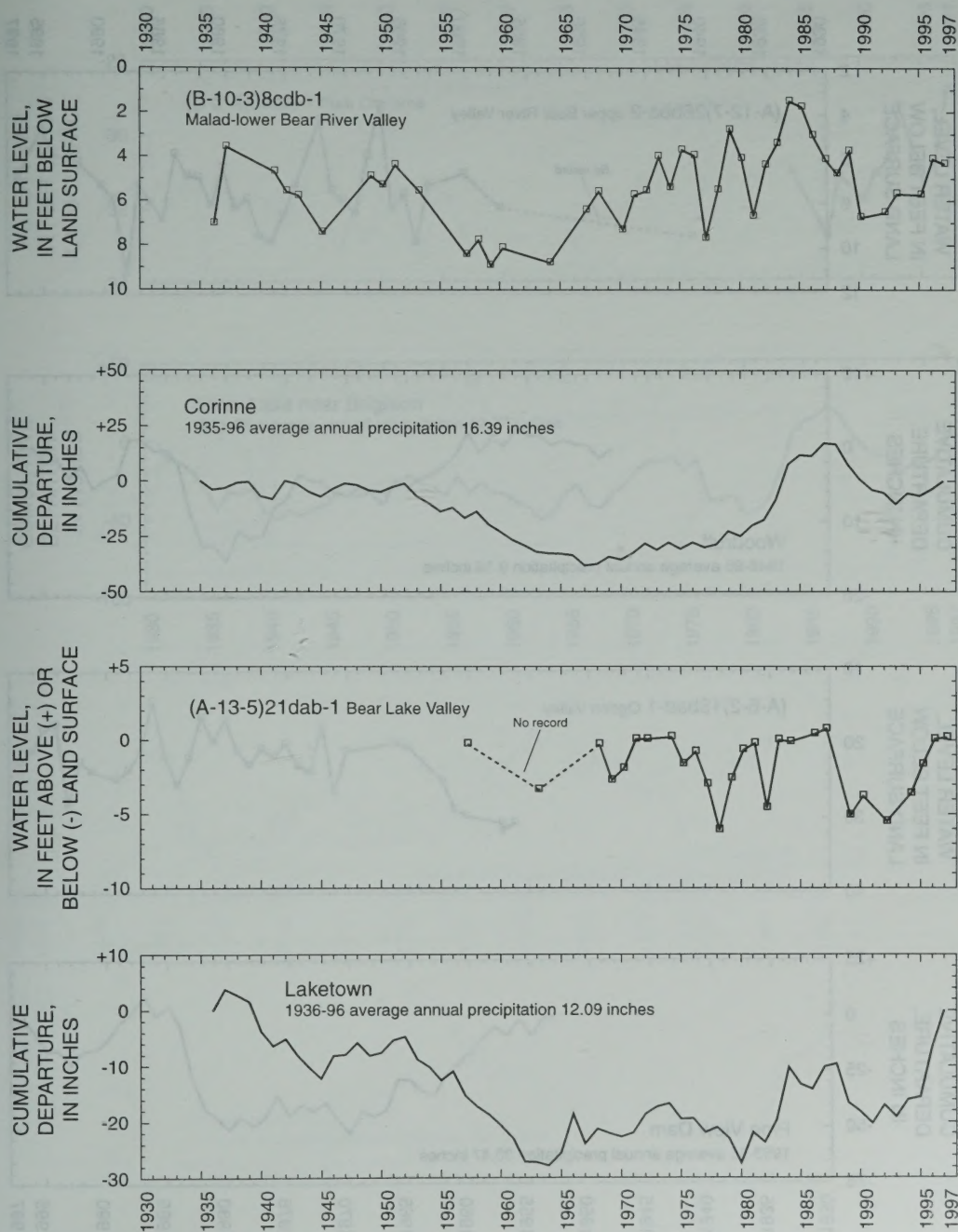
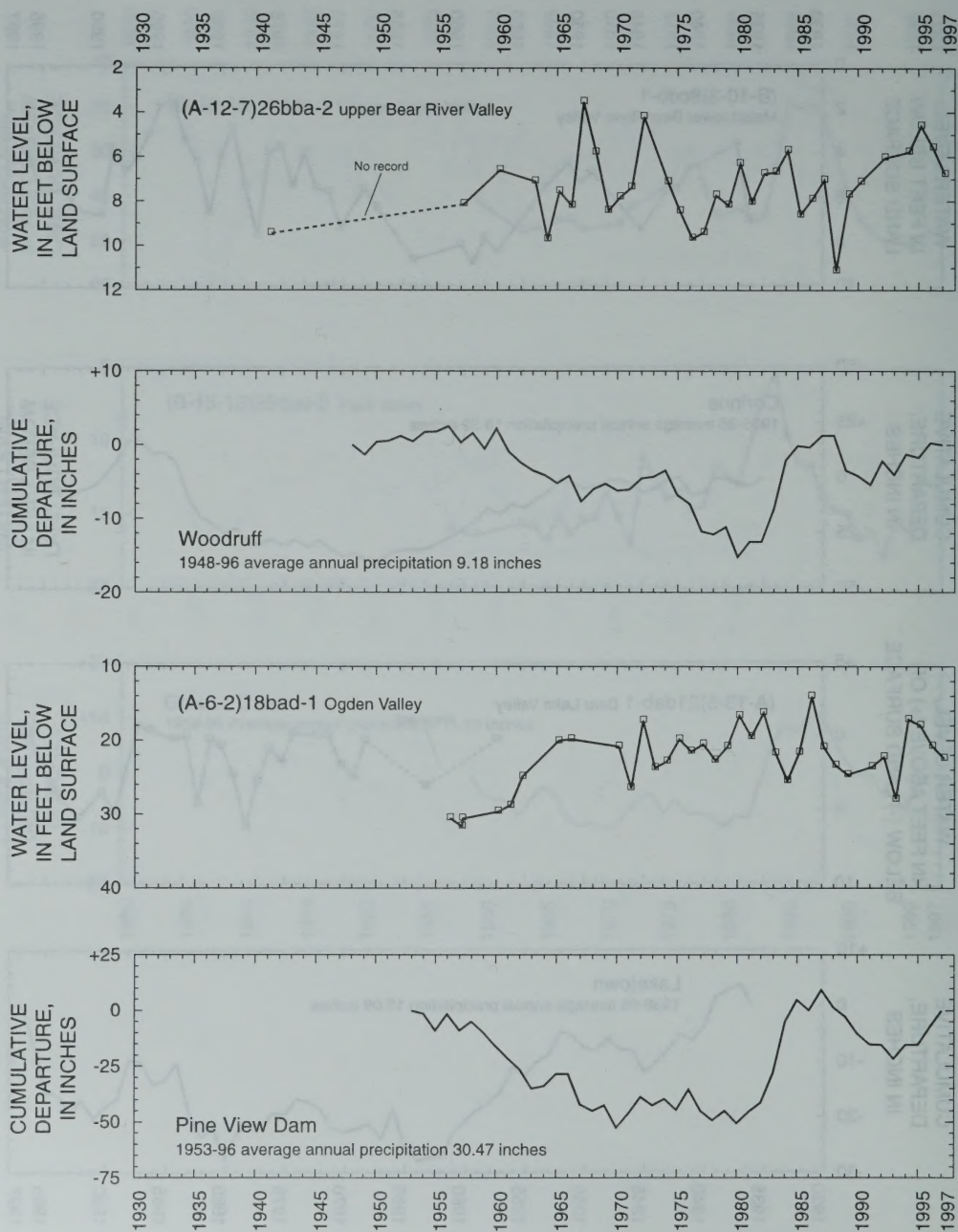


Figure 38. Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas.



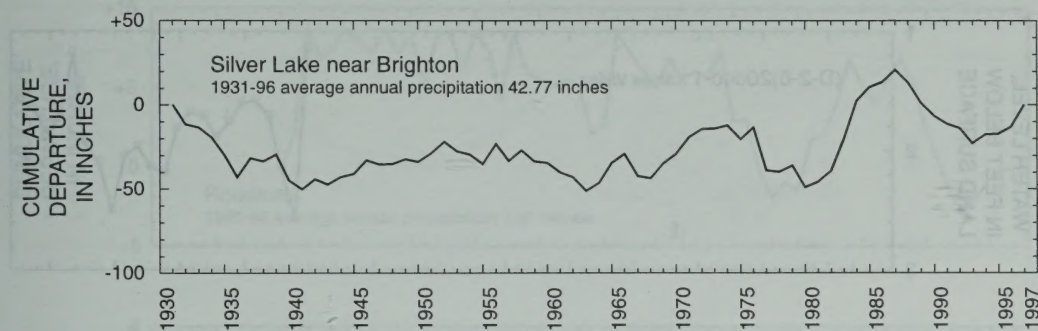
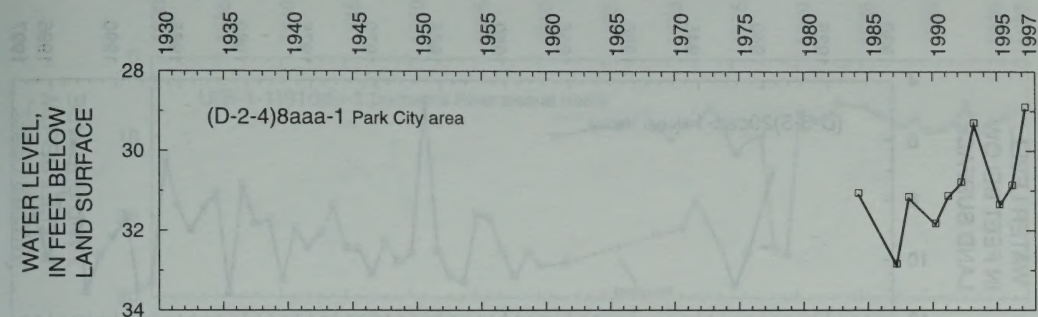


**Figure 38.** Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas—Continued.

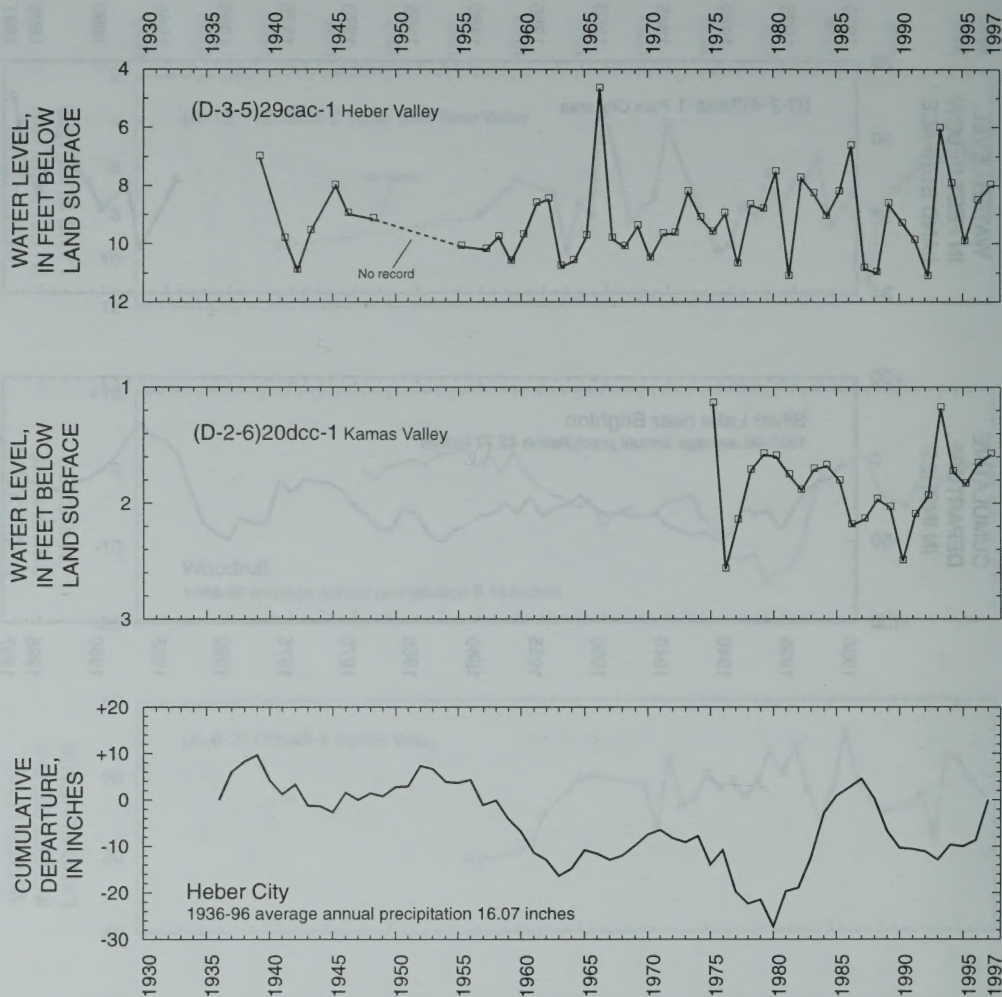


**Figure 38.** Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas—Continued.



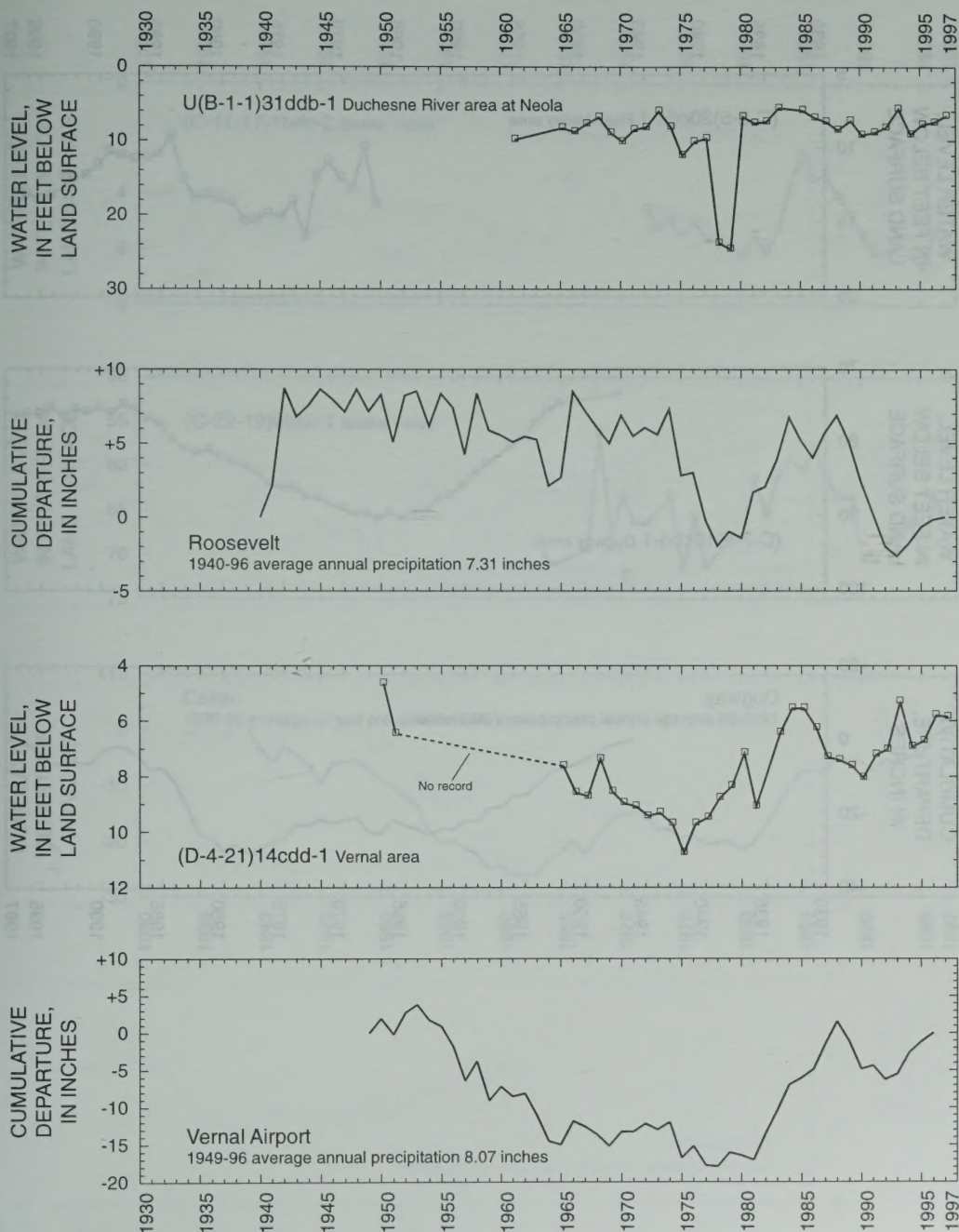


**Figure 38.** Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas—Continued.



**Figure 38.** Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas—Continued.





**Figure 38.** Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas—Continued.

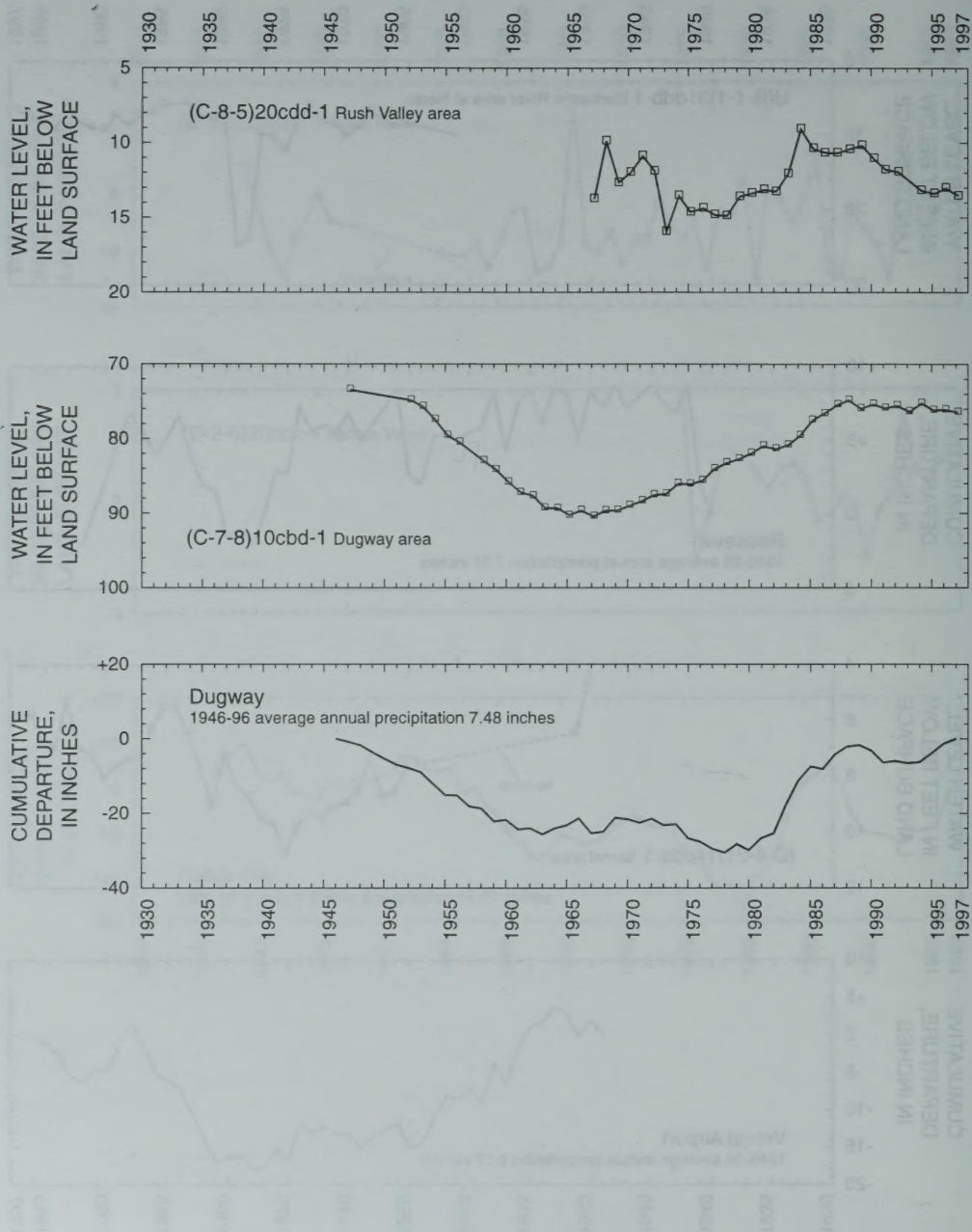
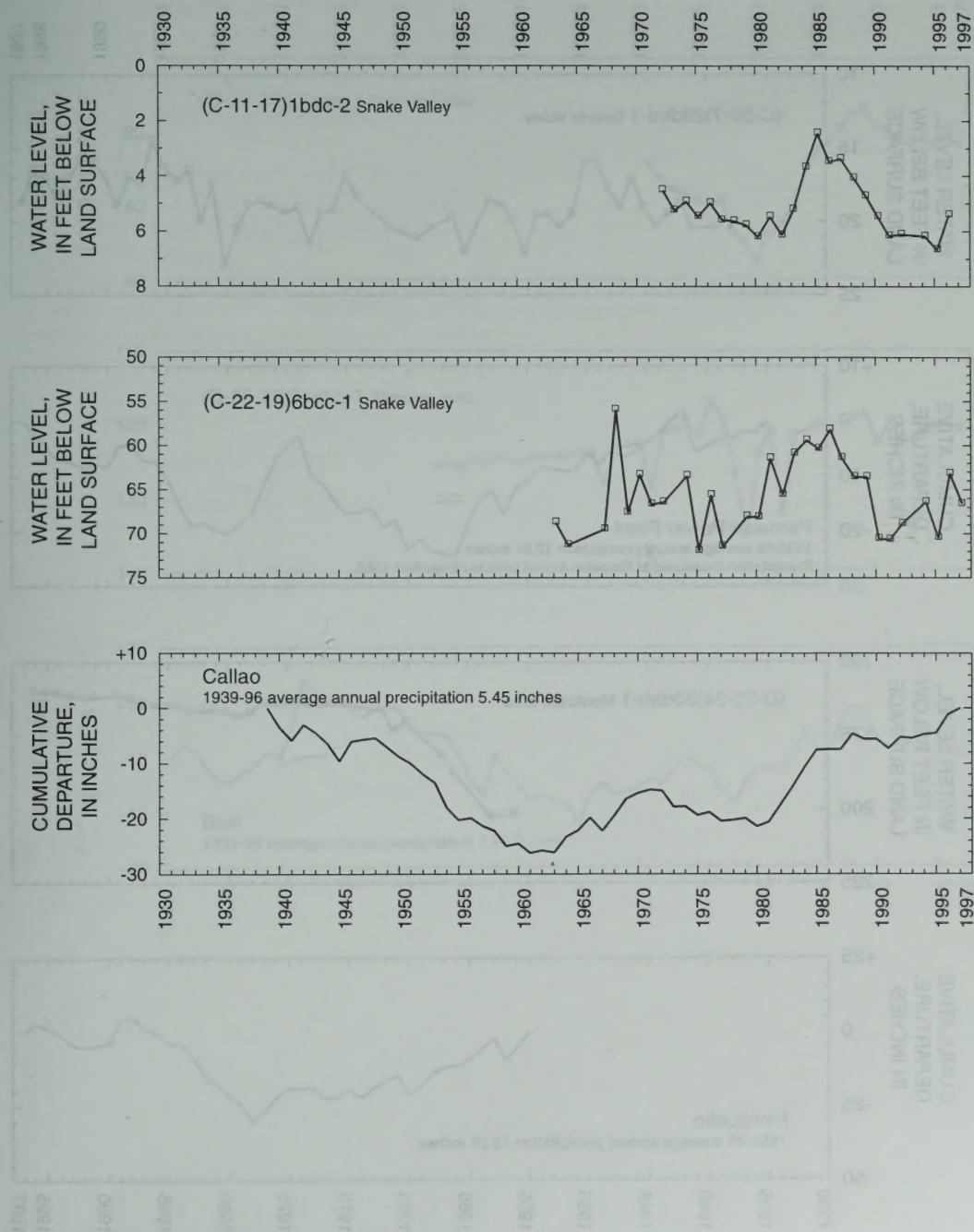
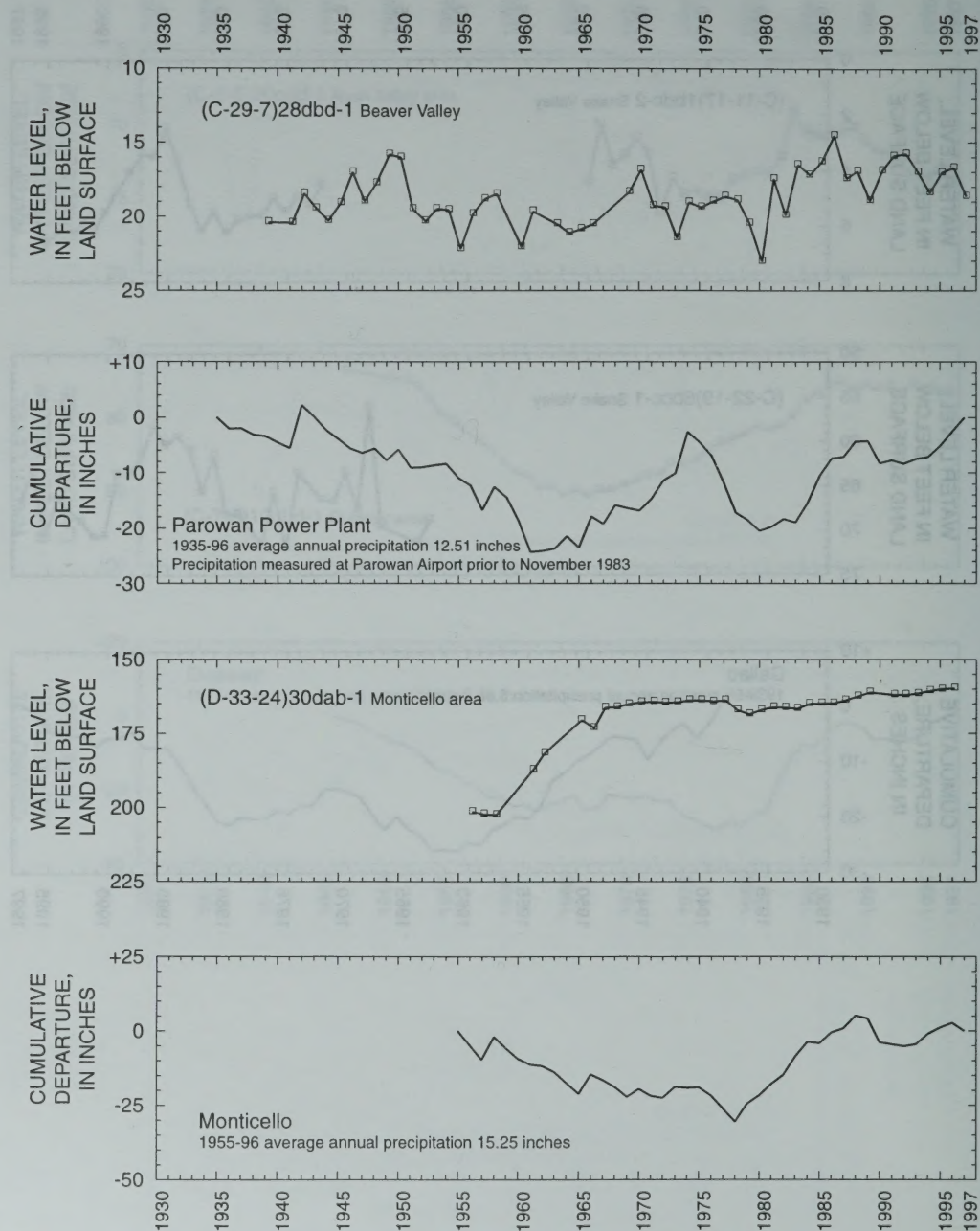


Figure 38. Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas—Continued.



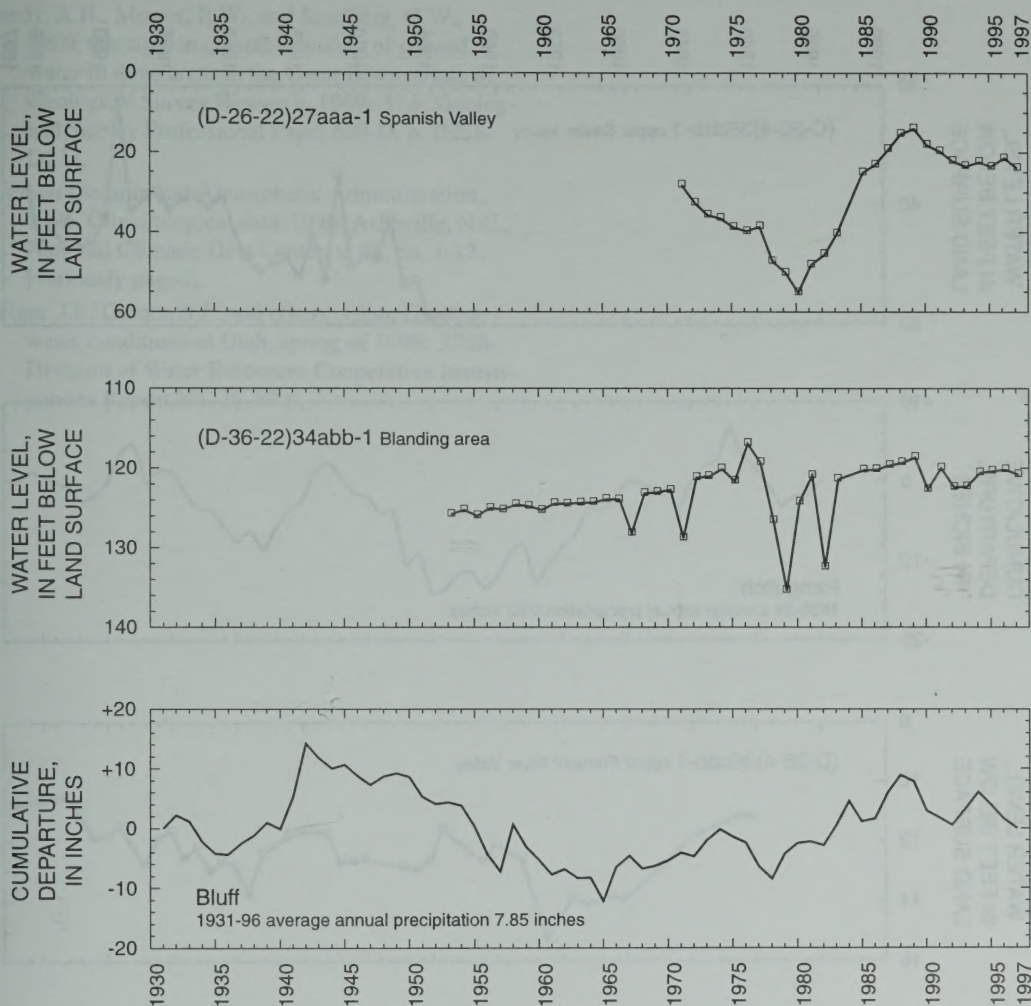


**Figure 38.** Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas—Continued.

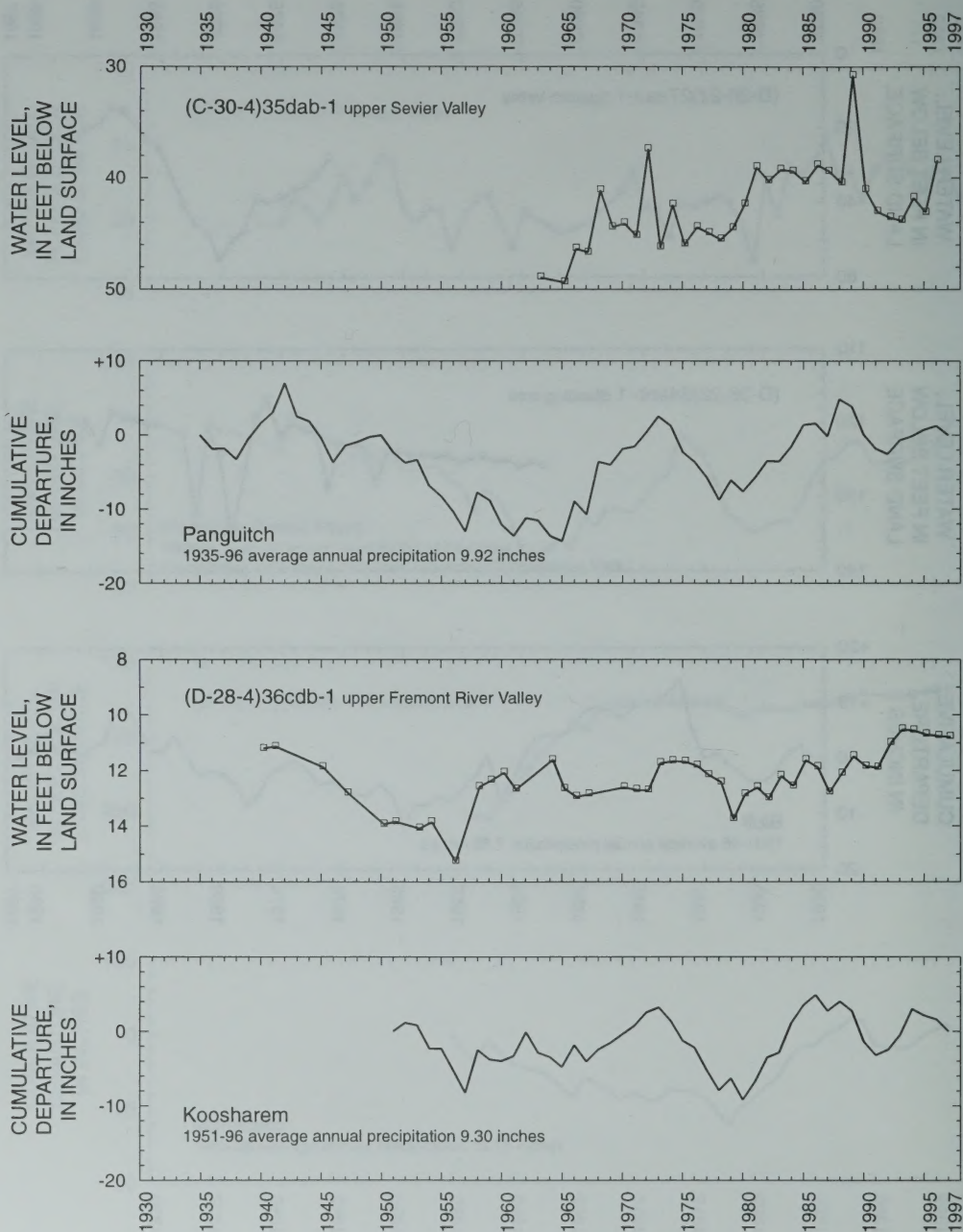


**Figure 38.** Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas—Continued.





**Figure 38.** Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas—Continued.



**Figure 38.** Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas—Continued.



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